1879.

QUEENSLAND.

REPORT

ON THE

GEOLOGY AND MINERAL RESOURCES

OF THE DISTRICT BETWEEN

CHARTERS TOWERS GOLDFIELDS AND THE COAST.

BY

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PRESENTED TO BOTH HOUSES OF PARLIAMENT BY COMMAND.

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REPORT ON THE GEOLOGY AND MINERAL RESOURCES OF THE DISTRICT BETWEEN CHARTERS TOWERS GOLDFIELD AND THE COAST.

Townsville, 14th May, 1878.

SIR,

I have the honour to forward herewith my Report on the Geology and Mineral resources of the District between Charters Towers Goldfield and the Coast, with two relative maps.

I beg to acknowledge my obligations for assistance rendered by Mr. W. S. E. M. Charters, Goldfield Warden; Mr. John Archibald, Mining Registrar; Mr. Thomas Buckland, Assayer; and Mr. Silas Harding, late Mining Surveyor, at Charters Towers. To the courtesy of the last-named gentleman I owe the completion of the map on which I have laid down my observations, south of the Burdekin, and also the lines of the principal reefs—services which enabled me to devote a larger proportion of my time to field work than would otherwise have been possible.

I have, &c.,

ROBERT L. JACK.

The Honourable the Minister for Works and Mines.

REPORT.

It was at one time my intention to deal with the Northern Goldfields apart from the geology of the surrounding districts, and to furnish maps and descriptions, from time to time, of such regions as the carrying out of my instructions should lead me to traverse.

As the district lying between the Charters Towers Goldfield and my head-quarters at Townsville must necessarily be often traversed in different directions in the discharge of my duties, I might reasonably hope to be able eventually to examine its geology in some detail, and to produce a map to some extent free from the errors inseparable from haste. The temptation, therefore, to deal with the goldfield alone, and to postpone the description of the surrounding district till a greater mass of information should be at my command, was for a time very strong. In the course of my work, however, it soon became evident that the materials already accumulated were at least sufficient to elucidate many circumstances in the history of the goldfields, and that it would be worth while, even now, to present such a view of the geology of the district, as a whole, as would place the public in possession of a key to the structure of the Coast Range and the Burdekin valley, leaving the blanks in the map to be filled up from time to time as occasion might offer.

This Report is accompanied with two maps:—

(1.) A detail map of Charters Towers Goldfield, on the scale of four inches to the mile (twenty chains to the inch).

This map shows the lines of the principal reefs with their underlie and the area occupied by the various rock formations at the surface.

(2.) A general map of the district between Townsville and Charters Towers, on the scale of half-an-inch to the mile, showing the area occupied by the different rock formations so far as the localities have been visited by me, and giving other information of economic importance.

This map extends northward from Charlie's Creek to the coast, and from Hillgrove on the west to Woodstock on the east. It embraces an area estimated at 5,700 square miles; but of these I have, as yet, examined only about 1,650, and therefore I cannot speak of the rest with any degree of confidence. Some large gaps therefore appear on the map to be filled up at a future time. The most important of these gaps is the district around Ravenswood, which is shortly to be made the subject of a special survey.

The notes to be made use of in the following memoir were accumulated mainly in the months of October, November, and December of last year. Three weeks were spent in the Star district, one month at Charters Towers, and the remainder of the time was occupied in investigating the geology of other parts embraced in the general map, with frequent changes of camp. Two short expeditions undertaken during the preparation of the present report—the first to inquire into the alleged discovery of coal near the head of the Ross, and the second with reference to a water supply for Townsville—afforded opportunities for a more detailed study of some parts of the area embraced in the maps.

ALLUVIUM.

(Recent.)

Symbol on Maps, V.

As regards alluvial deposits made by the existing streams when at or near their present levels, an important difference may be observed between the seaward and the landward sides of the Coast Range.

The seaward slope of the range is short and precipitous. In ascending from this side, the tops of the cliffs may almost be said to form the watershed; the escarpment looking seaward is, in fact, the edge of a table land whose natural slope is towards the Burdekin. Between the short north-eastern fall and the Pacific is a wide plain, co-extensive with a horizontal deposit of sandstone, breccia, and conglomerate. This deposit (to be more fully described under the next heading) is of a very modern date, geologically speaking. One evidence of this fact is that the streams have cut through it only very insignificant

channels

channels, and these channels have in but a few instances shifted much from their present position. Consequently, while there is a considerable accumulation of gravel and sand in the beds of the rivers themselves—to be pushed out into the sea with every freshet—there is a marked absence of the alluvial flats which fringe all large rivers that have flowed for some time in their present courses. It is true that floods now and then deposit gravel and mud beyond the channels of the rivers, but these deposits are seldom extensive.

In the gravel of the rivers on the coastward side of the range, gold in small quantities has been found. During January and February of this year, parties working on the Ross River, near the Kennedy Hotel, were rewarded by the discovery of some little nuggets, but nothing took place deserving the name of a rush, and the place has already been abandoned. Discredit has, as usual, been thrown on the genuineness of the discovery, but I see no ground to question the possibility of the occurrence of gold on the coast side of the range, in spite of several unsuccessful attempts on my own part, and a general disbelief prevalent among practical miners. The gold at the Kennedy Hotel was probably derived from Mount Stuart.

On the other side of the range the case is different. Down the slope of the table land there is every reason to believe that the same rivers have been engaged in wearing down the ancient rocks since a very distant period of geological time. They have carved out deep channels, and have frequently shifted their positions, leaving at intervals deposits of alluvial sand and gravel eroded from the upper portions of their banks. These deposits are not, as a rule, very extensive, and could scarcely be shown on the small-scale map. A few of the areas, occupied by recent alluvial deposits, are shown on the large-scale map of Charters Towers, at Brennan's and Mosman's Creeks. Another extends along Sandy Creek, from Jacobson's homestead to the Mary Louisa crushing machine, but its boundaries are ill-defined, and I have not traced them on the map.

Most of these flats on the inland side of the range have yielded more or less gold, but the so-called alluvial workings of this region have been in many cases mere washing of the gravel in the river beds, taken by preference from sheltered holes and crannies among the bed-rock. Some narrow strips of alluvial on creeks to the south of Charters Towers have been very thoroughly explored, and have yielded gold in considerable quantities. Among these are the Seventy-mile, a tributary of the Broughton, and the streams among the mountains lying between the Seventy-mile Creek and the Clarke branch of the Broughton—viz., Fenian Gully, Two-mile Gully, Eight-mile Gully, &c.

In the last-named region, Mosman, Clarke, and Frazer were working alluvial in 1872, when the distant hills of Charters Towers attracted their attention, and induced them to make the prospecting tour which resulted in the discovery of a new reefing district. The European diggers shortly afterwards rushed in a body to Charters Towers, and the Chinese flocked to the abandoned field in such numbers that there are said to have been at one time 7,000 of them at work on the Two-mile Gully alone. The place at present has the appearance of having been most thoroughly turned over, a great deal of surfacing having been done in addition to the washing of the alluvium. At the date of my visit (14th December last) less than half-a-dozen men were at work at alluvium in this range. They were meeting with moderate success, although the difficulties of washing were very great at the time. The dirt had to be carried in bags, sometimes for half-a-mile, and washed with water raised by windlasses from shafts on abandoned reefs. The method employed was generally to sink shafts to the bottom of the alluvial gravel, and drive tunnels along the surface of the bed-rock. When discussing the reefs and the palæozoic strata containing them, there will be opportunity of referring again to the surfacing operations.

Narrow alluvial flats on several small streams between the Two-Mile Gully and the Clarke branch of the Broughton, have also been pretty thoroughly worked out.

Alluvial diggings at Brook's, eight miles south of Rishton, occupied in 1872, one hundred men, according to Mr. Gold Commissioner MacDonald's report.

Ever since the opening of the Charters Towers Goldfield, a few miners have been working alluvial, on Mosman's, Sandy, and Gladstone Creeks and their tributaries; generally speaking, only the gravel in the actual beds of the rivers has been worked. The figures in the Warden's returns are sufficient in themselves to show that after the first rush the reefs alone were systematically worked, the alluvium being left to the casual efforts of the otherwise unemployed. In 1872 no less than eight hundred men were working alluvial. In 1873 and 1874 the number was reported at fifty. In 1875 it had dwindled to thirty. Next year it rose to one hundred and thirty, and 1877 it fell to twenty.

These figures, however, included men working at "deep leads" of older date than the recent alluvial deposits. They indicate on the whole, rather the fluctuations in the prosperity of other mining districts than the richness of the alluvial in this.

The difference between the gold derived from quartz reefs on the Charters Towers field and the amount escorted, as shown on the table, page 109, must be divided between alluvial and tailings; but it is now impossible to say in what proportions.

Some of the tributaries of the Little Star River, more especially Dry or Scrubby Creek, have for a good many years attracted a few miners, whose desultory labours have been fairly, but seldom, richly rewarded. One man was at work there as late as the month of September last. The workings, so far as I could trace them, had all been in the beds of the creeks, where the latter came down to the rolling downs out of a range of mountains composed of quartzite, mica, schist, and hornblendic gneiss. With the view of testing whether the gold was distributed further to the west, my two men (Donald Mackenzie and Henry A. Brock)—both experienced diggers—bottomed in several places on a creek flowing through country of the same character as that at the head of Scrubby and Melon Creeks, northward, into the Little Star River, about three miles from its junction with the Great Star, and washed a considerable quantity of the dirt with a purely negative result. Water to wash with was, however, obtainable only with great difficulty at the time, so that a thorough prospecting of the locality was out of the question.

POST-TERTIARY.

Symbol on Map, A.

Between the steep north-eastern escarpments of the Coast Range and the sea lies a great plain. Its extent does not strike the ordinary traveller, whose horizon is a circle, with a radius of half-a-mile, at which distance the trunks of a well-grown forest of poplar gum, Moreton Bay ash, and bloodwood trees seem to converge. This

This plain is co-extensive with a deposit of half-consolidated sandstone, grits, breccias, and conglomerates.

The sandstones, &c., lie with their original horizontality undisturbed. Owing to the gentleness of the slope from the range to the sea (300 feet in 16 miles, or 1 in 278), the present rivers have not had fall enough to cut deep channels, and the denudation of the plain has not gone far. To these circumstances the plain owes its flatness.

Instructions received in the end of January last, to inquire into a reported discovery of coal on the Ross River, gave me an opportunity of studying this deposit in greater detail than its economic value would warrant. A full description is given in a report "On the probability of the existence of a coal-field in the neighbourhood of Townsville," so that a short abstract of the characteristics of the deposit will suffice in this place.

The materials of the sandstones, grits, and conglomerates forming the floor of this great plain are generally recognisable as having been derived from the nearest portion of the range, or of its outstanding spurs. Thus, at the heads of the western branch of the Bohle River, the breccia is composed mainly of diorite blocks; at the One-mile Creek, near Thornton's Gap, granite prevails in the conglomerate; and in the upper reaches of the Ross River, the grit is almost entirely made up of very little abraded granite *débris*.

The sandstone is not sufficiently coherent to be of any value for building purposes. It is loosely cemented together with carbonate of lime. Generally speaking, fragments of the sandstone, after being dried, fall away to a heap of sand on being left in the water for a few hours. Some beds are still unconsolidated sand. The conglomerates and breccias, being only aggregations of stones (of all sizes up to one cubic foot), with a sparse matrix of grit, are, as a rule, not fit for anything but road metal—blinding. Occasionally, however, the breccia is so hard as to require blasting. This is especially the case among the lowest beds of the formation. Limestone nodules, commonly arranged in horizontal layers, occur everywhere throughout the finer beds of the formation. The sandstones are frequently cemented together, and stained in irregular masses by peroxide of iron.

In the western branch of the Bohle River (at the point where it approaches closest to the new Dalrymple road), I obtained in October last from a sandstone bed of this formation, a *Unio*, of the species now inhabiting the creeks. In February last, while enquiring into the supposed coal-bearing nature of the formation, I noted the occurrence in a conglomerate bed on the banks of the Ross River (at the One-mile watering place south of the crossing on the Charters Towers and Townsville road), of a number of fragments of mammalian bones. These were to some extent mineralised, but appeared to have been a good deal decayed before this process set in, so that it would be hopeless to attempt assigning them to the animal to which they belonged. In a lower part of the same bed I found what appeared to me an artificially-sharpened implement of the porphyry of Mount Stuart. If I am correct in this belief, the formation must be referred to the human period, whatever remains of organisms other than man it may hereafter furnish. I have submitted the supposed implement to Mr. Karl Staiger and Mr. Augustus Gregory for their opinion, and intend to forward it to Mr. Ramsay, Director-General of the Geological Surveys of Great Britain, and Mr. John Morris, two of the highest living authorities on flint implements.

In the Bohle River, half-a-mile above the Hotel, there occurs a soft half-consolidated bed of greyish-brown sandstone covered with a crust of white salt. It would be interesting to know whether the salt had effloresced from the sandstone itself, or had been deposited on the evaporation of the water in the pools. The water remaining in adjacent pools at the time of my visit, did not taste perceptibly salt.

About a mile to the north of the hotel on the Broughton, at the foot of the range, two grit beds are exposed in a little cliff of about 6 feet high. The rock is ferruginous in part. Its cement is carbonate of lime and peroxide of iron. It weathers unequally and fantastically. The topmost bed is about two-feet thick, is much stained with peroxide of iron, and is coarser in grain and better cemented than the underlying white bed. The upper bed tends therefore to form overhanging ledges, and the lower is hollowed into numerous caves.

The following section (Fig. 1) will explain the relations of the grit at this place to the older rocks.

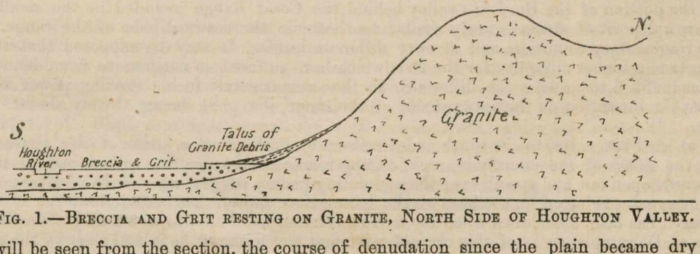

Fig. 1.—Breccia and Grit resting on Granite, North Side of Houghton Valley.

As will be seen from the section, the course of denudation since the plain became dry land has covered the edge of the sandstone with a *talus* of granitic *débris* from the mountain side. This is the case almost everywhere at the foot of the range, and it may be remarked that the best soils of the district are found where the calcareous grit is overlaid by a thin covering of granite *débris*.

Some circumstances regarding the levels of the margin of the plain at different points are of peculiar interest.

At the head of Lagoons Creek, a tributary of the Ross, where the formation thins out against the palæozoic rocks forming the narrow neck between the Round Hill and Mount Frederick, its surface is higher, probably by as much as 100 feet, than the opposite side of the neck in the head of the eastern branch of the Bohle River. This circumstance naturally suggests the former existence of a continuous barrier

barrier connecting the Round Hill with Mount Stuart and ponding back the waters into an inland sea or lake, which may have found its outlet (if it had any) in the direction of Major Creek. The western edge of the mountain mass of Mount Stuart, as will be seen from the map, is skirted by the Ross River. And yet, as is proved by the fact that not a single creek falls into the Ross from the west along the whole of this district, the plain slopes to the west. How then did the river take this singular course—flowing northward out of the open plain, abutting against a mountain, and crossing for at least 10 miles the highest instead of the lowest ground on which it could possibly flow? The only explanation must be that when, by the lowering of its outlet, the bed of the lake or inland sea became dry land, the waters of the rivulets falling down the steep side of the mountain began at once to carve away, and lodge in the place of, the soft rock at the edge of the plain which first checked them in their headlong course, and thus the river, flowing from the south—perhaps in the act of bursting the barrier alluded to in the last paragraph—found a channel already made.

It is probable that the sedimentary formation of the plain is of no great thickness, although its almost perfect horizontality does not permit of an estimation being made except where its base is actually visible. It may be seen resting on the palæozoic rocks in the One-mile Creek, near Hume's Range Hotel, and at the heads of the Bohle River and Lagoons Creek. For almost five miles of the upper part of its course, the Ross River flows over a bed of granite or porphyry, while its banks are composed of sandstone and conglomerate. Many smaller creeks in the same neighbourhood exhibit similar sections. In all this region, therefore, the sedimentary formation has a thickness not greater than the depth of the trench cut by the river, or less than 40 feet.

The presence of fresh-water shells and of mammalian remains, as well as the marked differences of level in what to the eye appears a dead flat, would seem to indicate a fresh water rather than a marine origin for the formation in question.

It is most likely that the strata were deposited in a great lake or series of lakes, or possibly in salt lakes without outlet. The lake was probably very shallow, and often dried up sufficiently to allure the inhabitants of prairie and forest to roam over its bed, where they were destroyed in great numbers on the return of the rains.

The necessity for *shores* to this lake is a difficulty which will suggest itself at once to every one. But it is not improbable that a range of sunken mountains in the portion of the Barrier reef may have divided its waters from the ocean. It will be remembered that Darwin's theory of coral reefs requires for the growth of the Great Australian Barrier the submergence of a range of mountains or chain of islands.

Although the sandstones, &c., rest on lower palæozoic rocks, and there is, therefore, no direct stratigraphical evidence on the point, the following circumstances are relied upon to prove the recentness of their deposition.

The deposits have suffered no disturbance, but lie for the most part in their original horizontal position.

They have undergone no alteration except a partial consolidation by the percolation of carbonate of lime derived from the decomposition of bone, or shells, or of both.

They have suffered no denudation of any consequence. The modern rivers meander through them, but have neither carved out deep valleys nor left extensive deposits of alluvium; a thin coating of alluvial loam here and there over the plain is due to modern floods.

They are not pierced by the dolerite dykes, understood to be of late Tertiary age, which traverse every other formation in the neighbourhood.

They contain at least one fresh water-shell (*Unio*), identical with the species now inhabiting the creeks.

They contain mammalian remains, rather decayed than fossilized.

They contain doubtful traces of the presence of man during their deposition.

From the whole evidence I am inclined to believe that the deposits in question represent the "Diprotodon-Breccia" of Daintree,* in which the remains of extinct mammalia are associated with those of recent fresh-water mollusks.

Detailed information regarding the deposit in question will be found in the "Coal" report above referred to.

In the portion of the Burdekin valley behind the Coast Range included in the small-scale map, there occurs a deposit of strata entirely similar to those on the seaward side of the range, but in an extremely fragmentary condition, and at very different levels. It may be supposed that this circumstance points to a higher antiquity for the beds which have suffered so much more from denudation; but I am rather inclined to ascribe the difference to the comparatively feeble eroding power of the rivers intersecting the formation on the seaward side of the range, the plain being already almost at the level of the sea.

In at least two cases, to the south and south-east of Millchester, strata of this character formed chiefly of the *débris* of the underlying rock, occupy for some distance the narrow beds of little gullies, and afterwards open out and spread over the undulating plains, suggesting mouths of rivers opening into lakes. In the cases referred to, the base of the loose gritty deposit has been followed as a "deep lead;" but the search has been abandoned when the narrow channel was found to widen out. On the road from Townsville to Dalrymple, rocks of this character are first met with on the inland slope of the range to the west of "The Springs," about six miles down the valley of the Speed. The beds seen on the left bank of the Speed in a little dry creek are of coarse breccia, and on the right bank, at the foot of a granite hill, sandstone of granitic *débris*. This locality must be at least 1,000 feet above the level of the sea. If we suppose the deposits in question to be of marine origin, we must admit that an elevation to the extent of at least 1,000 feet has taken place since post Tertiary, perhaps even in recent times; an admission which I should make with extreme reluctance in the absence of further proofs. It is possible that the sedimentary rocks occupy in Speed Valley a much greater space than I have assigned to them on the map, but it certainly does not now cover the whole of the valley, whose bottom at various points is composed of rolling downs and low "tors" of granite.

About

* Quart. Journ. Geal. Soc., Lond., p. 274. See, also, Rev. W. B. Clarke's "Sedimentary Formation of New South Wales," 3rd Edition.

About midway between Star and Dotswood Stations is another patch. As seen in the northern stream, it consists of a coarse grit of granitic *débris*, with the component fragments scarcely at all rounded, a bed of hard siliceous sandstone, and a grit bed, containing semi-rounded blocks of white quartzite, or hardened sandstone, up to five inches in diameter. The lines of bedding are not recognisable. In a creek about a mile south is a coarse grit of granitic *débris*, with traces of horizontal bedding.

Hardened white sandstone or quartzite, understood to be of Devonian Age, is known to occur in the valley of the Keelbottom, about eight miles nearer Dotswood. This formation was probably the source of blocks above alluded to as occurring in the grit.

About three miles south-west of Hamilton's Crossing, on the Burdekin, the road from Charters Towers suddenly mounts to the top of a little crag of ferruginous granitic grit. For the next two miles, although the rock is not visible, the subsoil is a light sand derived from the decomposition of sandstone or grit. This part of the road is flanked by a dense low scrub, probably co-extensive with the patch of stratified rocks.

On the right bank of the Burdekin, below Rishton, Mr. T. Buckland discovered some fossil wood in a similar grit. He also found on the same side of the river, opposite Gilgunyah Head Station, some mammalian bones, which he sent to the Australian Museum, Sydney. In answer to my inquiries, Mr. G. P. Ramsay, Curator of the Museum, was kind enough to give me (in a letter dated 17 January, 1878) the following account of the fossil:—

"The fossil you allude to in your note of the 7th instant, is the portion* of the lower jaw of a species of *Diprotodon*, probably the young of *D. Australis*, or perhaps a new species."

The "deep lead" to the south-east of Millchester occupies, as has already been said, the narrow bed of a gully. In following it, it was found that the bottom deepened towards the source of the creek, crossed the watershed,† and fell into a creek on the other side. A re-arrangement of the drainage system, implying the denudation of a large mass of rock, is thus proved.

Two miles south of Millchester, the very singular rock known as the Little Red Bluff rises about 100 feet above the level of the plain, or rather downs. It has a flat top about a quarter of an acre in extent, bounded by an escarpment about thirty feet in height. (See fig 2.)

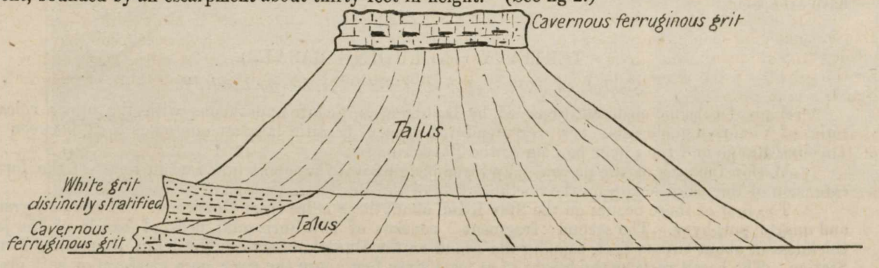

Fig. 2.—Section of Little Red Bluff, looking South.

The rock of this escarpment is a grit or sandstone much stained with peroxide of iron, which sometimes follows lines of vertical or horizontal points. It is made up mainly of granite *débris*, viz., granules of quartz and a matrix of decomposed felspar, mica being also noticeable on washing. The only evidence of stratification is, that the grit varies in coarseness along horizontal lines. The scarp is indented with caverns whose form has been determined by the weathering of the ferruginous cement in the vicinity of joints. The caverns are apt to be most frequent in the finer sandy portions of the rock. When this sand is white it has a distinctly saline taste.

The north-west side of the escarpment has been extensively quarried in terraces, and is said to have yielded some gold.

The strata forming the middle portion of the hill are concealed by a *talus* from the crowning escarpment. At the foot of the hill a thick mass of white grit, distinctly stratified, overlies a cavernous ferruginous bed.

The Bluff stands in the middle of a line of shafts, about three-quarters of a mile in length, which runs from north-west to east along a course whose convexity is towards the south. On descending from the hill it is seen that the shafts are all sunk in grit similar to that of the Bluff. Commencing at the north-west end of the line, this grit begins at a quartz reef, which has only been prospected a little at the surface, is confined for about a quarter of a mile to the valley of the Imperial Creek, leaves this valley and makes straight for the Bluff, continues beyond the Bluff in a somewhat wider belt *across* the course of another creek, and opens out to a comparatively large area in about three furlongs further. The shafts get fewer and fewer as the lead widens, and cease when it begins to spread over the plain. On the plain the grit forms several little escarpments, sometimes resting on granite. I did not trace its boundaries very far eastward through the forest, owing to the want of landmarks and maps, which would have rendered the work too tedious.

The "drift" ‡ of the Little Red Bluff, and of the deep lead in connection with it, has been tried again and again for gold. Quite a rush to it took place about two years ago, but without much success. The number of shafts sunk attest, however, the earnestness with which success was for a time believed in.

From an examination of such of the shafts as remained open at the date of my visit, and of the washdirt, I arrived at the conclusion that comparatively few had reached the true bottom of porphyry or granite, and those that had done so were all near the north-west end of the lead where the deposit is shallowest, and where the bottom could be reached at a depth of only about twenty feet. Below the point

* Anterior portion of *rami* of lower jaw, with three molar teeth, of *Diprotodon Australis*.—*Young*.

† To prevent confusion, I may observe that I use the word in its proper sense, for "the line of the parting between waters." In the district I find that the word has acquired a new meaning, which can be expressed better by the phrase "drainage area."

‡ The resemblance of the grit to the auriferous drifts of Victoria, strikes the Victorian digger at first sight.

point where the Imperial Creek leaves the deep lead, all the shafts appear to have been sunk only to the base of the bed of white grit seen in the above section of the hill; the underlying ferruginous bed having evidently been treated as the bottom.

The isolated "Bluff," standing at least 100 feet above the general level of the grit, bears witness to the extent of the denudation to which the latter as well as the underlying rock has been subjected. It is impossible with the present system of hill and valley to reconstruct the shores of the lake or inland sea in which the grit was deposited.

The deep lead to the south-east of Millchester employed the energies of a large number of diggers on the first rush to the new field in 1872, when a good many made considerable hauls. This lead has more conspicuously "paid" than any other alluvial workings on the field. As has already been pointed out, the lead deepens across the watershed into a valley draining to the east.

A coarse granitic grit is seen in the bed of Ivor's Creek,* about a mile from its junction with Sandy Creek. It is more than likely that large areas are covered by the grit besides those marked on the present map.

If, following the example set at Red Bluff, the grit is to be regarded as a "deep lead," it is needless to say that alluvial mining in this district has hardly been begun. It would be advisable, however, to confine operations in the first instance to leads in the vicinity of known auriferous reefs. Gold is more likely to occur in such deposits in hollows of the bed-rock, near the shores of the old lake or inland sea, than in its interior.

It may be well to quote as a warning Daintree's observation,† that "it is doubtful if any *marine* or *extensive lacustrine beds*, except on their shingle margins, have produced, or are ever likely to produce, remunerative workings of *free* gold, for the simple reason that the majority of the sediments of which they are composed are derived from formations, the greater part of which were non-auriferous."

I should advise any Townsville capitalist willing to spend money in a bold mining experiment, to prospect the bottom of the grit of the plateau at the edge of the Coast Range, were it not that the granite of this portion of the range is poorer in quartz reefs than any granite district of equal extent that I have ever seen.

TERTIARY (INCLUDING BASALT).

Symbols on Maps:—For stratified rocks, b; for basalt, B.

A great volcanic outburst, regarded by Daintree as "contemporaneous with the upper volcanic series of Victorian geologists," has overspread with beds of basaltic lava an enormous area between the Dividing Range and the upper portion of the Burdekin.

Within the area of the present map three insignificant fragments now remain to attest the former extension of this basaltic lava on the northern side of the Burdekin Valley.

The first of these occurs on the Star Road, about three miles from Dotswood. It rests on granite and quartz porphyry. The second "fragment" consists of two horizontal beds of basalt, of the joint thickness of about twenty feet, capping the island on the Burdekin between Burdekin Downs and Long's Station. The basalt rests at the height of at least sixty feet above the river, on a platform of soft clayey strata.

There is no evidence bearing on the age of the basalt within the area embraced by the map, but if we regard it as "pliocene tertiary" (according to Daintree), it follows that the underlying sixty feet of clayey strata must be either of pliocene or older date. The geological parity existing between this and the auriferous drifts of Victoria may some day lead to a systematic search for the precious metal below the basaltic capping.

A third fragment of basalt forms a little round hill about four miles east of the Star Station. It rests apparently on granite. The hill stands about 150 feet above the surrounding granite downs. A little rock of basalt crops out on the road half-a-mile north of the hill.

Dykes of a similar character, and presumably of the same age as the basaltic lava-flows, traverse the older rocks in various places, as shown on the maps.

SANDSTONE, &c., CAPPING THE HILLS BETWEEN THE HOUGHTON AND KIRK RIVERS.

Symbol on Maps, c.

A very striking cliff, forming the edge of the table-land of the Coast Range, arrests the attention of the traveller from the road down the Houghton Valley. It was found, on re-ascending the range for the purpose, to be composed of sandstone and conglomerate, dipping slightly to the south.

The slope of the mountain for about 500 feet above the bed of the creek is of granite and gneiss. The sedimentary formation rises above this in a series of cliffs, estimated at 400 feet in height. The sandstone is of mixed felspathic and siliceous materials. It is, generally speaking, a somewhat coarse grit, in which sometimes felspathic and sometimes siliceous granules predominate; some beds are of fine and soft, mainly felspathic materials, and weather into large caves, much frequented by the rock wallaby and the swallow. In the perpendicular cliff of 200 feet are many beds of conglomerate, with pebbles up to two inches in diameter of yellow porphyry, quartz, and quartzite. In some bands the pebbles are almost all quartz. Crossbedding is common. The sandstone has mainly the chocolate-brown tint of the lower old red formation of Scotland, sometimes with a shade of green added. Without more time than I could spare, I could not find a cleft sufficient to enable me to surmount the lower (200 feet) cliff, so that the

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* To avoid long descriptions of localities, I have been forced to give names to some creeks, hills, &c., which, so far as I could learn, had none. The principle on which the names have been given is the one which should cause the least difficulty in identifying the localities. Thus, Ivor's Creek is the creek falling into Sandy Creek, beside Ivor's house; Imperial Creek, the creek flowing past the Imperial machine; Plant's Range, the hills adjoining the residence of Mr. Plant, the well-known mill-owner; and so on.

† Geology of Queensland, p. 278.

the upper cliffs had to remain unvisited. There is, however, little doubt that they also are sandstone and conglomerates, probably divided by beds of shale. Rounded blocks of quartzite, reaching nine inches in diameter, are met with resting on the granite of the hill slope. I could not find the bed from which these blocks came. It is probably at the base of the lower cliff, concealed by a talus.

The following section, sketched from a hill ¼ mile to the north of the cliff, gives an idea of its appearance at the north-west corner.

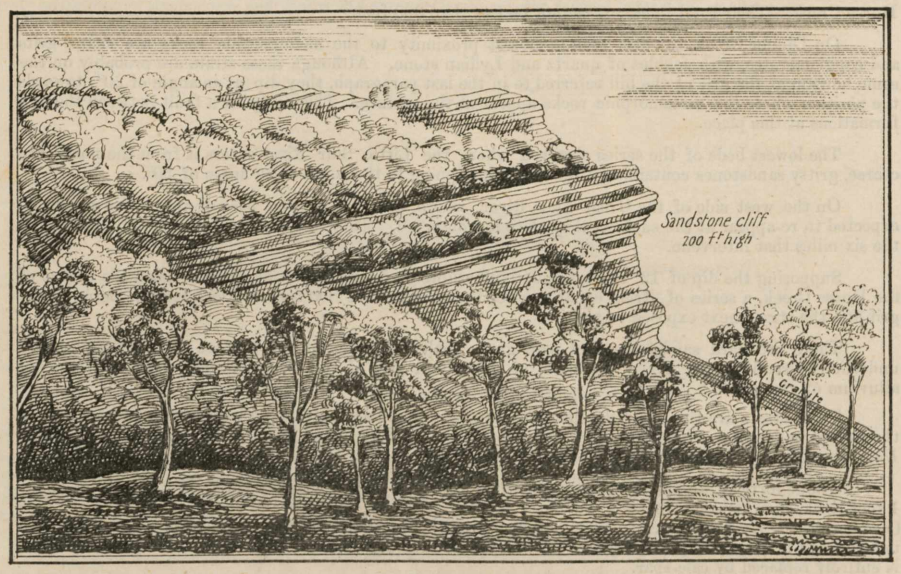


Fig. 3.—Sandstone capping Granite Hills, South of Houghton Valley.

The only fragments of evidence tending to fix the age of this deposit are as follows:—

The deposit is newer than—because it overlies—the pre-Devonian granites and gneisses of the Coast Range. It is probably newer than the Devonian rocks of the Burdekin Valley, which I understand to be the source of the quartzite pebbles in the conglomerate.

It may possibly be contemporaneous with the brown conglomerates of Dotswood, from which it does not differ very widely in lithological character. These rocks are understood to be Devonian, but higher in the series than the limestones and quartzites of the Burdekin Valley.

The formation probably extends over a considerable portion of the table land between the Haughton and Kirk Rivers. Further opportunities may offer for exploring it, and in the meantime it would not be safe to indicate its age with more precision than to say that it is newer than at least a part of the Devonian rocks, and older than the "Desert sandstone."

DEVONIAN.

It would be unreasonable to expect that any close parallel could be drawn between the sedimentary rocks of Australia and Europe. The presumption is that, in regions so distant, the strata whose included organic remains bear the strongest resemblance to each other, were *not* deposited contemporaneously. Professor Huxley proposes the term "homotaxis" to describe relations of this sort subsisting between distant formations. All that can be claimed for the Devonian system in Queensland is, that it is not contemporaneous but homotaxial with the European system.

UPPER DEVONIAN.

Symbol on Map, d.

To this age is referred, on palæontological grounds, a series of strata occurring near the Star Station at the junction of the Little and Great Star Rivers.

Similar strata are understood to exist in the upper basin of the Star, but I have not visited this region.

I have

I have traced with some care the boundaries of the series near the Star Station, partly because former hasty surveys had given rise to the erroneous impression that the fossils found here determined the age of the whole of the sedimentary deposits occurring in this part of the Coast Range, and partly in the hope of finding a passage from Devonian upwards into carboniferous strata.

The base of the series is a coarse, hard siliceous sandstone or grit, with quartz pebbles, well exposed in a hill to the south of the road 3½ miles south-south-east of the Star Station. Overlying the granite of the downs, and dipping to the west at an angle of 12°, the grit presents an escarpment to the east which rises some 200 feet above the level of the downs. A good section of the same beds is seen in Horse Creek. Their total thickness cannot be less than 300 feet.

On Dinner Creek, the beds seen in closest proximity to the metamorphic rocks are coarse grits and conglomerates, with pebbles of quartz and Lydian stone. Although these strata are probably on the same horizon as the grit of the hill referred to in the last paragraph, they dip (at an angle of 20°) towards the position where the metamorphic rocks appear at the surface. There may be a fault between the two formations at this place.

The lowest beds of the series observed where the Little Star River enters it from the north, are coarse, gritty sandstones containing a few pebbles, dipping to the south at an angle of 30°.

On the west side of the Great Star River, where the grits at the base of the series might be expected to re-appear at the surface, they were not observed. They may quite well have thinned out in the six miles that intervene.

Supposing the dip of 12° to continue uninterruptedly from the grit of the hill down the course of the Horse Creek, a series of strata equal to a vertical thickness of 800 feet should intervene between the grit and the strata next exposed to view.

There are hard sandstones and pale green shales, dipping to the west at 15°. They probably underlie the section seen nearly opposite, on the south side of the road on the left bank of the old alluvium of the creek.

These strata are thin-bedded calcareous sandstones and shales, dipping west at 30°, and containing the following fossils:—*Orthis, chonetes cracowensis*, one undetermined *gasteropod, lepidodendron nothum Unger*, acc. to Carruthers (Syn. *L. Australe*, McCoy), *Cyclopteris*, &c.

About forty yards further east on the same bank is a bed of coarsely crystalline limestone, about 1 foot thick, showing, on weathered surfaces, sections of shells—*spirifer* and *orthis, eucrinites* and corals (*cyathophyllum?*). A microscopic examination proved the limestone matrix in which the larger fossils are imbedded to be a mass of *foraminifera*. The forms of the larger shells are perfect, but their substance is entirely replaced by calc-spar.

South of the station paddock, the same (Horse) creek exposes in two places shales and hard dark blue sandstone, dipping to the south-east. There is, therefore, a synclinal trough between these and the last described strata.

In the Little Star River, at the mouth of Horse Creek, is a coarse conglomerate of quartz pebbles, dipping N.W. at 60°. Following the river bed northward, a set of green shales and fine hard calcareous sandstone is seen just below the ford, dipping to the south-east at 20°. Here the two reversed dips probably indicate a synclinal trough. The axial line of the trough may be faulted, as it is occupied by a mass of intrusive porphyry. The strata in this trough must occupy a higher horizon than any other exposed to view within the area of the basin. Continuing northward up the river, the strata are traversed in a descending section, the dip being for the most part to the south-east.

A few hundred yards above the ford, a band of porphyry is crossed. This porphyry is traceable to the next bend of the river (about three miles west). It follows the line of strike of the sedimentary rocks, but is probably intrusive.

North of the porphyry is seen a bed of coarse conglomerate. This bed is traceable for a mile and a-half to the copper mine road.

Shortly to the north of this, about a mile from the Star Station, a little creek (which, for convenience of reference, I call Donald's on the map), falls into the river on the north bank. It shows the following section dipping to the south (at 20°), and consequently underlieing the coarse conglomerate (beginning at the topmost beds at the mouth of the creek).

	Thickness in feet.
Blue shales with ironstone nodules and impressions of *Lepidodendron* and thin hard limestone bands	80
Impure blue limestone	2
Shales	15
Hard sandstone	1
Alternating bands of shale and fine hard calcareous sandstone, the sandstone bands containing shales and the shales-plant remains	50
Alternating hard sandstones and shales	40
Concealed room for	20
Alternating hard sandstones and shales	10
Confused and mostly concealed shales at intervals—room for	100
Fine dark-blue limestone or cementstone with conchoidal fracture—in 3 beds...	3
Shales and hard sandstone with *Lepidodendron*	20
Hard dolerite-like sandstone (weathering spheroidally in parts) with *Lepidodendron*	30
	371

At

At this point (about a furlong up Donald's Creek from its mouth) an anticlinal arch begins to repeat the strata in reverse order, but they are only imperfectly seen, long intervals being concealed by vegetation.

About a quarter of a mile up Brock's Creek, which falls into the river nearly opposite Donald's Creek, is a section (dipping to south at 25–30 degrees) of hard yellow sandstones and greenish calcareous bands and hard shales, similar to the beds in Donald's Creek. A curious case of contortion in the upper beds, not continued into the lower beds, was noted here, due, I imagine, to the unequal contraction of the purely sedimentary sandstones and shales and the partly chemically-formed calcareous sandstones.

Fig. 4.—Contortions in Sandstones and Shales, Brock's Creek.

Forty or fifty yards further up the creek and dipping below the beds in the above section occurs a bed of blue crystalline limestone at least twelve feet thick; it has a conchoidal fracture and a metallic ring when struck with the hammer; it is precisely similar in texture to the limestone of Donald's Creek. Thin transparent sections of this limestone, examined under the microscope, revealed no traces of organic remains.

The coarse conglomerate of the Little Star River and the strata exposed in Donald's and Brock's creeks may be supposed to represent a good part of the upper portion of the gap of 800 feet on Horse Creek.

Returning to the river and continuing the section to the north of Brock's Creek, a mass of yellow acidic felspar porphyry (intrusive?) is first met with, and presently the grit already referred to as occurring at the base of the series.

At the westmost angle of the Great Star River, and midway between the Coppermine road and the new Etheridge road, a little stream (called, for distinction's sake, Corner Creek) falls into the river. Near the mouth of the creek is exposed a thickness of about 12 feet of green shales, dipping S.S.W. at 30°. The shales proved to be exceedingly rich in organic remains, chiefly in the form of casts. Among these the following are recognisable:—*Cochliodus; Griffithides dubius*, Eth.; *Orthoceras; Goniatiles; Chonetes Cracowensis*, Eth.; *Orthis; Spirifera undifera*, Römer, var. *Undulata*, Dav.; *Rhynchonella; Productus cora*, D'Orb; and a large number of undetermined *Brachiopoda; Loxonema impendens*, McCoy; *Natica; Euomphalus*, 2 species; *Pleurotomaria; Bellerophon;* at least 2 species of *Encrinites, Lepidodendron nothum*, Unger acc. to Carruthers (Syn. *L. Australe*, McCoy).

At the mouth of Sandy Creek is a bed of sandstone dipping to the south, and probably underlying the Corner Creek strata.

On the western branch of Sandy Creek, near the Grave, is a bar showing a thickness of about 20 feet of bluish shales, somewhat calcareous, dipping to the south-east at 20°. The shales are covered with a mass of *Lepidodendron* and calamites.

Similar shales also with *Lepidodendron* are seen in the eastern branch of the creek, turned up on end. Possibly a fault divides the Devonian strata from the metamorphic slates, &c., and conceals their lowest beds.

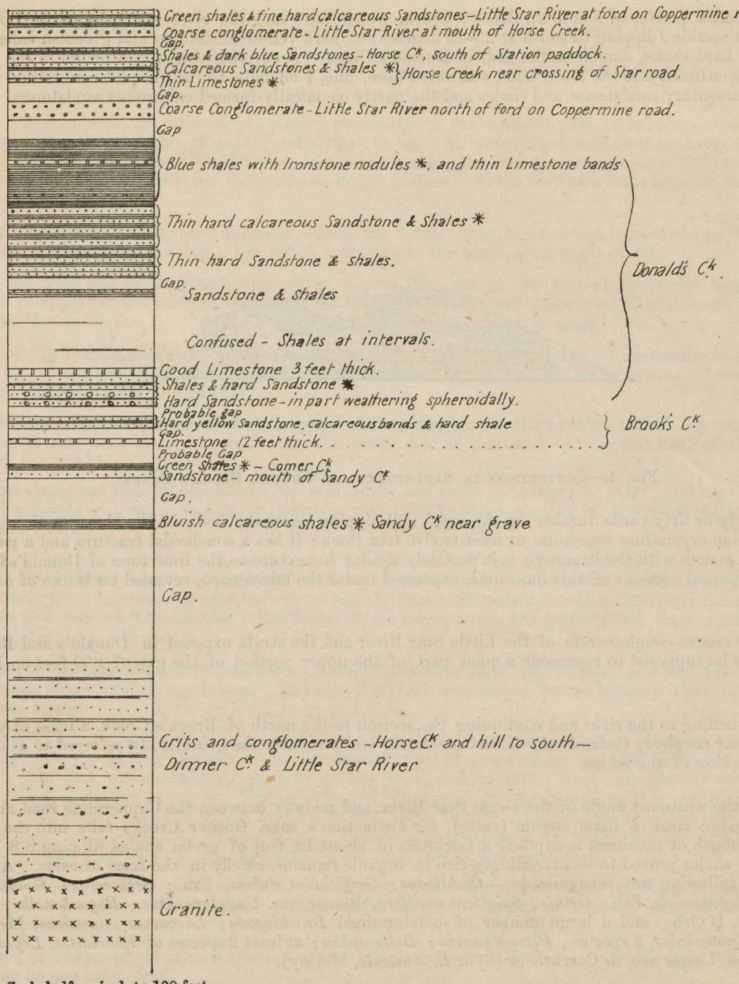
The Sandy and Corner Creek beds should occupy a position in the lower part of the gap in the Horse Creek strata.

The mistaken zeal of palæontologists to settle horizons by fossil evidence has often led to great confusion, and to damage to the interests both of zoology and geology. I, therefore, state here, and without any prejudice whatever, that the stratigraphical evidence warrants the following order of succession, and no other, in the strata of the *Lower Star Basin*, whatever conclusions may be drawn from preconceived ideas regarding the range of the fossils—when these shall have been determined:—

LOWER

LOWER BASIN OF STAR RIVER.

Table of Strata.



Scale half-an-inch to 100 feet.

Strata which have proved fossiliferous are distinguished by an asterisk.

But until other areas of contemporaneous rocks in Australia or elsewhere have been so worked out as to admit of being similarly tabulated for comparison, I see no advantage in treating the fossils of the Lower Star Basin otherwise than *as a whole*.

The following *ad interim* list of fossils collected from the Lower Star Basin during the recent trip includes fossils from all the different localities above-named.

Pisces.—*Cockliodus*? (tooth only).
Crustacea.—*Griffithides dubius*? Eth. (Pygidium only).
Cephalopoda.—*Orthoceras*; *Goniatites*.
Brachiopoda.—*Chonetes Cracowensis*, Eth.; *Orthis*; *Spirifera undifera*, Römer, var. *Undulata*, Davidson; *Rhynchonella*; *Productus cora*, D. Orbigny; besides a large number of other species undetermined.
Gasteropoda.—*Loxonema impendens*, McCoy; *Natica*; *Euomphalus* (3 species); *Pleurotomaria*; *Bellerophon*.
Lamelli Branchiata.—*Tellina mariæburiensis*, Eth., and one other species undetermined.
Echinodermata.—At least two species of *Eucrinites*.
Anthozoa.—*Cyathophyllum*.
Plantæ.—*Lepidodendron nothum*, Unger (acc. to Carruthers); (Syn. *L. Australe*, McCoy); *Calamites*; *Cyclopteris*.

After spending a good deal of time in the attempt, I was forced reluctantly to admit that the result of my efforts could only bring about confusion in the realms of palæontology, were I to confer specific names upon the fossils with more precision than I have done above. With only a few books, and with no named specimens for comparison, it would be impossible to avoid errors both of omission and

and commission. The whole collection will be submitted to Mr. Robert Etheridge, junr., F.G.S., late of the Geological Survey of Victoria, acting Palæontologist to the Geological Survey of Scotland, author of a Catalogue of Australian Fossils, now being published by the University of Cambridge. Mr. Etheridge has kindly promised to undertake the determination of the Queensland fossils, a task for which he is specially qualified.

There can be no doubt of the identity of the strata of the lower basin of the Star River with the Mount Wyatt beds. Mr. Robert Etheridge, F.R.S., referred both (in 1872) to the Devonian Age, and stated* that they are succeeded unconformably by the carboniferous rocks of the Don River. It appears to me, however, that there is such a correspondence between the fossils from the Star and those of the Don River, as given by Daintree, that it would not be surprising if the strata of the two localities should yet have to be placed on the same horizon. But it is useless to speculate on this, in the absence of stratigraphical evidence, till the present large collection has been worked over by a palæontologist.

It may be here pointed out that the Lepidodendron common to the Star, Mount Wyatt, Canoona, Gympie, and Broken River beds, and to the beds of the Avon River, Gippsland, has been identified by Carruthers† with Unger's Devonian *L. Nothum*, while Professor McCoy ‡ names it *L. Australe*, and considers it nearly identical with Sternberg's *L. Tetragonum* (*L. Quadrangulare*), Unger. Professor McCoy regards the Gippsland, Gympie, and other strata containing this fossil as of Lower Carboniferous Age.

MIDDLE DEVONIAN OF DALRYMPLE AND DOTSWOOD.

Symbol on Maps, E.

In designating this formation in the meantime, Middle Devonian, I mean to indicate nothing more than my belief in its intermediate position between the horizon of the Star beds and that of the Burdekin Downs limestone.

The Star beds are Upper Devonian, if not, Lower Carboniferous.

The coral limestone of Burdekin Downs is understood to be on the same horizon as that of the Broken River, a tributary of the Clarke.

The Broken River limestone is pronounced by R. Etheridge, F.R.S., on palæontological grounds, to be Lower Devonian or Siluro-Devonian.

From the direction of the dip of the Burdekin Downs limestone and of the sandstone at Dalrymple, I infer, although not without some hesitation, that the latter deposits overlie the former.

I have nowhere seen the base of the Dalrymple and Dotswood group of sandstones and conglomerates.

In Keelbottom Valley, near Dotswood, the strata of this formation dip to the east at 30° and form distinct ridges across the road and in the bed of the river. Taking into account its high dip, and the extent of ground occupied by its outcrop, the series must be of considerable thickness; but as I have seen neither its highest nor its lowest beds, I cannot estimate it.

In this district, beds of brown felspathic sandstone alternate with conglomerates and red, white-spotted shales. The conglomerates contain pebbles up to six inches in diameter, the majority of which are of pink porphyry, a few being hardened white sandstone or quartzite. The quartzite pebbles may have been derived from a bed which immediately overlies the sandstone of Burdekin Downs, and if this be the case, the limestone must not only be older than the conglomerate, but must be separated from it by an unconformability.

The porphyry pebbles as well as the felspathic sandstones and the gritty felspathic matrix of the conglomerates, clearly prove that the deposit was derived as a whole from the waste of volcanic or metamorphic materials. It bears a striking resemblance to the Lower Old Red beds of Perthshire.

The beds on the left bank of the Burdekin, opposite Dalrymple, are of a character essentially similar to those of Dotswood. They consist of reddish and chocolate-coloured shales, and brown and chocolate-coloured sandstones. The sandstones are often cross-bedded, and sometimes flaggy, with faint ripple marks. In places they enclose little pellets of chocolate-coloured shale. Buff ferruginous spots are common in the interior of the sandstone. The shales are occasionally greenish, but the red and chocolate-coloured beds predominate. The red and chocolate-coloured shales frequently weather spheroidally, and are dotted with white spots.

The little hill called Mount Keelbottom consists of a pale pinkish porphyry with a base of acidic felspar, crystals of orthoclase felspar, and water-clear blebs of quartz. The porphyry has a quasi-schistose structure, especially noticeable on weathered surfaces. The same feature may be observed in the hill immediately opposite Dalrymple, where a series of escarpments coincides in direction with the outcrop of the sandstone beds. It is more than likely that the porphyry is a metamorphosed volcanic tuff. Whether it is inter-bedded with the sandstone strata, or is of older date, is a question that I am not prepared to answer at present.

The Dalrymple and Dotswood series has not, so far as I am aware, yielded any fossils.

On the left bank of the Burdekin, for three miles after the last is seen of the Dalrymple sandstones, no rock is exposed, but the fragments in the soil are almost all of porphyry, and it is almost certain that a mass of that rock intervenes between the sandstone and the coralline limestone of Burdekin Downs.

LOWER DEVONIAN OF BURDEKIN DOWNS.

Symbol on Map, F.

At Burdekin Downs, and for six miles up the river, the outcrop of a great limestone mass is seen at intervals. The area occupied by its outcrop is marked by a greener vegetation in the dryest season than that covering its burned-up surroundings. The limestone must have formed a coral reef of great thickness. On weathered surfaces the corals stand out in the most perfect relief, like triumphs of the sculptor's art. Under the microscope the cells of the corals are seen to be filled up with calcspar.

The

* Quart. Journ. Geol. Soc., Lond., xxviii., p. 324. Quart. Journ. Geol. Soc., Lond., xxviii., p. 286.

† Quart. Jour. Geol. Soc., Lond., xxviii., p. 353. ‡ Prodromus of the Palæontology of Victoria, Decade I., p. 37.

The corals seem to be mostly of the genera *Chætetes*, *Favosites*, and *Syringopora*. A few mollusca occur, but I was unable to obtain determinable specimens.

On a little creek between Arthur's Creek and Burdekin Downs Station the limestone is seen resting directly on granite. Here it dips about 10° to the north-west. Its outcrop occupies half-a-mile, and its thickness should therefore be about 450 feet. It is succeeded by a bed of fine-grained white hardened sandstone or quartzite.

About sixteen miles to the north-east of Burdekin Downs, on the Fanning River (three miles south of the Fanning Station), an extensive deposit of a similar character occurs. I have not yet visited this locality, and am unable to say whether or not the limestone is continuous with that of the Burdekin Downs.

Mr. Daintree describes a similar limestone at Terrible Creek, near Messrs. Cunningham's cattle station, Burdekin River.

The two views (figures 6 and 7) taken on the north bank of the Burdekin, between Burdekin Downs and Arthur's Creek, show the characteristic weathering of the limestone.

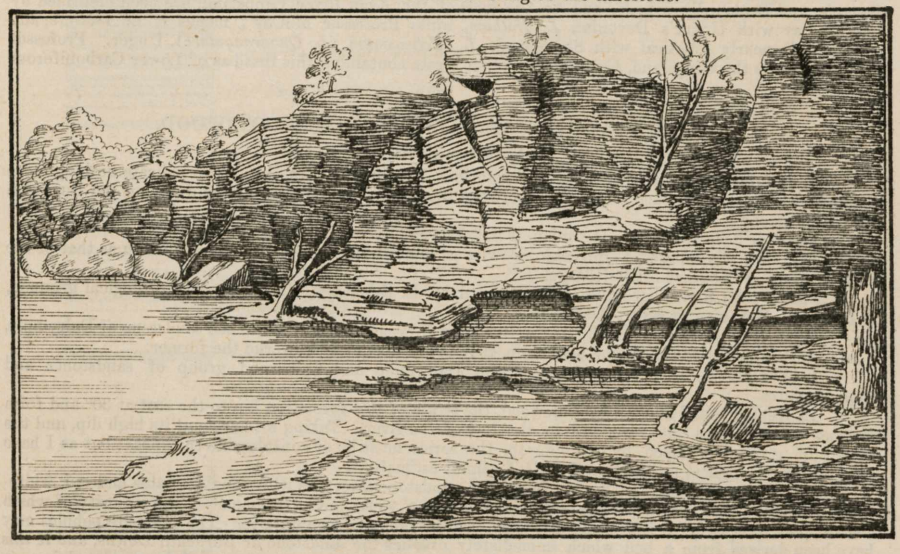


Fig. 6.—Limestone, near Burdekin Downs. From a Photograph.

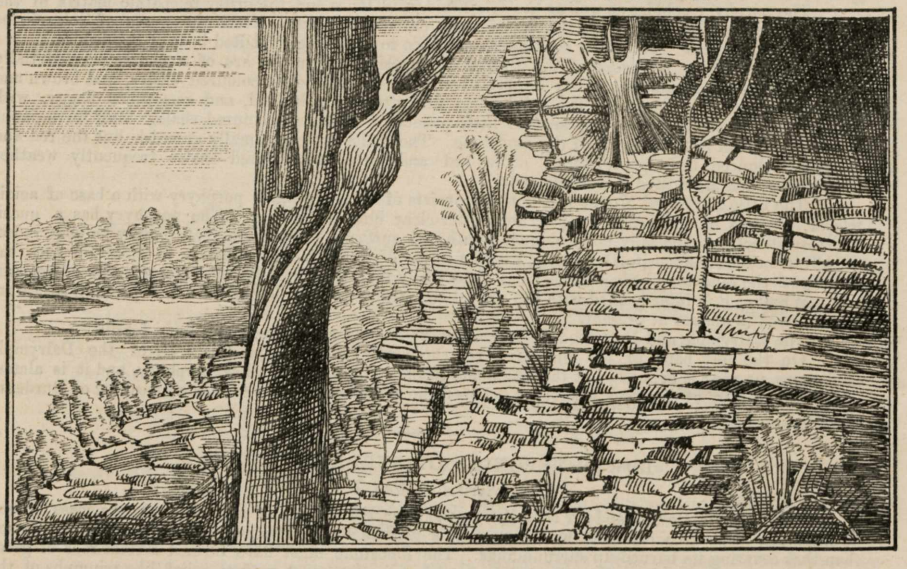


Fig. 7.—Limestone, near Burdekin Downs. From a Photograph.

PRE-DEVONIAN (SILURIAN) METAMORPHIC.

(*Symbol on Maps*, G.)

By far the greater part of the area embraced in the maps is occupied by rocks older than the oldest of the Devonian rocks above described. They are all metamorphosed in a greater or less degree.

The metamorphism must have taken place prior to the deposition of the Devonian rocks (if they *are* Devonian), above described, pebbles and granules of the metamorphic rocks forming the material of the Devonian conglomerates and sandstones.

The proximate cause of the metamorphism must have been the heat evolved during the shrinking of the earth's crust, owing to secular cooling.

To the same cause must be ascribed the crumpling of the once horizontal stratified rocks, now thrown into broad folds, and, probably, not occupying more than one-fourth of the surface over which they were deposited.

In view of the fact that the gold, copper, and tin mines of the district occur without exception within the metamorphic region, the importance of an exact definition of its limits and subdivision is obvious. To this object, therefore, I devoted as much time as I could afford, in the hope of laying a foundation for more detailed observations on the phenomena of the mines, than was possible during my short visit.

It is a circumstance worthy of remark that the richest gold deposits occur in the most highly metamorphosed rocks near their contact with the least metamorphosed rocks of the district. The latter occur to the north and west of Charters Towers, their boundary having been traced from the heads of the Broughton River, in a sinuous line northward, to the Burdekin, as will be seen by reference to the maps. They consist of quartzites (hardened sandstones of quartz granules), greywackes (hardened sandstones of mixed quartz, felspar, and horneblende granules, with some mica), slates, and shales. The slates do not differ from the shales in mineral composition—mainly silicate of alumina, with a high percentage of peroxide of iron—but simply in being intersected by cleavage planes. Both the slates and the greywackes are, as a rule, highly impregnated with iron, being in places "iron-masked" to such a degree that they might almost be taken for weathered clay-band ironstones.

The brick-red soil formed by the decomposition of the slates and greywackes, is incomparably the best in the district (excepting, perhaps, some alluvial patches), its richness being proved by the excellent results obtained by Mr. Pasquale Nigro, at his vineyard on Scrubby Creek. It generally forms but a thin covering, however, on the parent rock. Good land of this character will be found in many places between the Red Hill and the hill to the north-west of the Stockholm reef.

In the area in question the slates strike, as a rule, north-west and south-east. They dip at angles of 45 degrees or more, both to north-east and to south-west. Indeed, there is every probability that the same strata will be found repeated again and again in a series of sharp folds, although it is impossible to ascertain this with certainty, owing to the absence of extensive natural sections.

The cleavage planes of the slate appear to "strike" in the same direction as the bedding-planes, and to "dip" to the south-east at an angle of about 30 degrees. It is often very difficult to distinguish bedding from cleavage, especially where the strata are much "iron-marked," for instance, in the wales of the Great Britain reef.

Occasionally, where the "greywackes" are fresh and seem to contain little iron, they somewhat resemble blue limestone, while their joint-surfaces are sometimes coated with calcspar. These circumstances have led, in at least one case, to the erection of a kiln, and the experiment of burning a kilnful of the greywackes for lime.

A singular rock occurs in at least two places within the area coloured on the map to represent comparatively unaltered pre-Devonian rocks between Charters Towers and the Burdekin. At first sight it seems like the weathered, shaggy surface of a bed of basaltic lava. On further examination it is found to be a fine conglomerate of quartz pebbles, enclosed in a fine matrix of sandstone (mainly of felspathic materials), coloured dark-red with peroxide of iron. The two places referred to are on the Dalrymple road—the first five, and the second nine miles from Charters Towers.

In these, the least altered of the pre-Devonian rocks of the district, no fossils have as yet been detected. The possibility of their occurrence ought, however, to be kept in view.

Mr. R. Etheridge, F.R.S.,* states that the Broken River limestones, which he calls Siluro-Devonian (the equivalents of the Burdekin Downs limestones), are the lowest fossiliferous rocks in Queensland. But the latter beds are undoubtedly of much more recent date than the rocks last above described. The Rev. W. B. Clarke, erroneously, I think, ascribes to Mr. Etheridge the view that "nothing lower than Siluro-Devonian had been found in Queensland." No older *fossils* have been discovered, but lower (and older) stratified rocks most certainly have.

Mr. Clarke regards the slates of Brisbane as Upper Silurian, and it is likely enough that the slates and greywackes of Charters Towers may eventually prove to date from the same period.

Within this area of little metamorphosed rocks there occur several quartz reefs. Two of these, the "Great Britain" and the "Rose, Shamrock, and Thistle," were being worked at the date of my visit. Both run about 25 degrees to the west of north, and underlie to the north-north-east.

I visited the workings in the "Great Britain" mine which were being opened up by owners who had recently taken possession. They were working at a depth of about sixty feet. The underlie or hade is about 60 degrees. The country is slate, which to the depth reached in the mine weathers red, and breaks up in small angular pieces, so that to distinguish between bedding, cleavage, and joint planes is almost impossible. The hanging wall is distinct, but the foot wall is never certain. The reef is at least seven feet wide and contains a good deal of quartz (shewing a little mundic and some peroxide of iron) scattered through a "gangue†" of slate or *débris*.

The "Rose, Shamrock, and Thistle," reef, both in strike and underlie is parallel to the course of the "Great Britain." Crushings from the mines have yielded 2 oz. 7 dwts. to the ton.

It

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* Quart. Journ. Geol. Soc., Lon., xxviii., p. 324.

† Locally the term "formation" is employed in the sense of "gangue" or semi-tuffs between the walls; but as this word might mislead in a report, in which I must use it frequently in another sense, I use the word gangue instead.

It will be observed that the line of these reefs does not coincide with the strike of the slates, forming with it at an angle of about 20 degrees.

In the course of the survey, the out-crops of several quartz reefs were seen within the little metamorphosed area. One on the road from the "Great Britain" mine to Charters Towers runs due north and south, another on the Hayman's road, on the point behind Plant's Mill which overlooks the town, runs east and west. Other two, in the north-west corner of the area reserved for homestead selections, run north-west and south-east (coincident with the strike of the slates).

The "quartzite" beds in some cases so much resemble vein quartz, that prospectors have been induced to sink little shafts upon them.

Between Harvey and Chick's slaughter-yard and Cockfield's homestead, another band of slates is traversed. Here the strike of the slates is a little to the north of north-west, and the dip, wherever it is distinct enough to be noted, is (at a high angle) to the north-east. A few yards north of the old Townsville road, about a mile from Cockfield's, a reef of white amorphous quartz, running 20 degrees to the north of east, stands at least six feet out of the ground, with a breadth of about twenty feet. It appears to hade to the north, but of this I cannot be quite certain. It is pretty free of iron pyrites, or any foreign admixture whatever, and in short is of the character unfavourably regarded by the miners as a "buck-reef."

Over an extensive area in the Star district rocks of this age have suffered a greater degree of metamorphism than those last above described. The dip and strike of the sedimentary rocks are still recognizable, although a state of semi-fusion and plasticity which has supervened has permitted of the partial re-arrangement and crystallization of their component minerals.

A very coarse quartzite grit or fine conglomerate is seen in Cattle Creek near its junction with Keelbottom River.

On the hill to the north of this a felspathic slate appears to pass gradually into a pale yellow elvan or felstone. There is reason to believe that the slate is of volcanic origin (a fine tuff). Before Cattle Creek emerges from the hills to the north of the Star road it exposes sections of shales, greywackes, and coarse quartz conglomerates.

On the Star road, a mile west of Keelbottom crossing, a soft mica schist occurs, traversed by numerous veinlets of quartz. Similar schists, together with quartzose grits, occur on the western head of Cattle Creek. The surface in this locality is strewn with fragments of quartz, evidently derived from reefs.

A region of quartzose micaceous schists is traversed by the creek falling into the Little Star River below the Etheridge road.

The mountainous region whence Melon, Scrubby, and Dinner Creeks, and the north head of Cattle Creek, take their rise is composed of hornblendic schists and gneisses, with some quartzite beds. From this locality must have been derived the gold found in the alluvial deposits of these creeks, where they emerge from the hills.

Prepared slices of the gneiss of Dinner Creek examined under the miscroscope by transmitted light show that the rock is essentially composed in about equal proportions of hornblende crystals (generally passing on the edges into the condition of serpentine), and blebs of quartz, with rare crystals of plagioclase felspar, the whole being, so to speak, "peppered" with minute opaque specks of magnetic iron. Sometimes cubical specks of iron pyrites are visible to the naked eye.

Occasionally beds of shales, &c., appear to have been baked, shattered, and re-cemented in the form of hard breccias of Lydian stone, jasper, &c. Examples of this phenomenon are to be seen in the Round Mountain (east of Mount Frederick) and in the hills east of the camping place known as "The Springs," in Speed Valley.

On referring to the map, it will be seen that there is no regularity either in the strike or dip of the schists, &c., of the Star district. There is evidence of a very considerable degree of disturbance from forces exerted in various directions, and, probably, at different times. All that can be said with certainty is, that both the metaphorism and the disturbance had been effected before the deposition of the Devonian (or Carboniferous) rocks of the Lower Star Basin.

Over the whole of this area quartz reefs are numerous, and the soil is strewn with quartz fragments. It is, probably, from some of these that the gold has found its way into the streams. A thorough prospecting of the mountainous region, in search of the auriferous reefs themselves, may yet lead to better results than the desultory working in the dry beds of the creeks which have hitherto engaged the attention of the few miners who have been employed on this field.

In the "Round Mountain," already referred to, besides the Lydian stone and jasper breccias, there occur hornblendic grits which have suffered metamorphism, to some extent, in the direction of diorite.

It will be seen from the map that Mount Alice, Mount Frederick (with the exception of the Peaks), and Plant's Range at Charters Towers, are composed of diorite.

The transition is so easy from a felspathic-hornblendic stratified rock to a diorite of much the same chemical composition, with the materials re-arranged and crystallized, that the question whether the diorite is to be classed as metamorphic or intrusive, cannot be settled by the mere naming of the rock.

If we suppose the fusion (or heating to the extent of permitting the re-crystalization) of a mass of felspathic-hornblendic rock to take place at some depth in the interior of the earth, the portion which cools and consolidates in that position will be classed, when at length exposed to sight by denudation, as metamorphic or hypagene; the portion injected into joints and fissures, or between bedding planes, or along any line of weakness whatever in the superincumbent strata, and consolidating in that position, will be classed, even after denudation has removed the superincumbent mass, as intrusive, and the portion, if any, which escapes to the surface and cools there, will rank as volcanic. All three classes are called, in a loose and general way, "igneous." *

To the first of these classes it is most probable that the masses of Mount Frederick, Mount Alice, and Plant's Range belong. I nowhere observed any trace of an amygdaloid texture, although I looked for it carefully, especially at Mount Frederick, where the escarpment suggested bedding. The pits caused by

* Metamorphism may also be brought about (and indeed is certainly in progress in almost all rocks, exposed either to the percolation of water from above, or to the escape of gases or vapours from below), by the gradual decomposition of minerals and substitution of others.

by escaping gases and steam, and generally filled up by infiltration with other mineral substances after the cooling of the mass, almost invariably characterise volcanic rocks, and are very often present in intrusive rocks as well. Their absence from the diorite makes it probable that the latter did not consolidate at or near the surface. The Round Mountain, connected by a narrow neck with Mount Frederick, consists, as has already been said, to a large extent, of rocks whose original stratification is still recognizable, but which, in many cases, are almost diorites.

In Mount Frederick and Mount Alice the metamorphism is complete. The rock consists of crystals of a triclinic felspar, roundish blebs of quartz, and some hornblende crystals, scattered through a dark-grey matrix of felspar with magnetic iron. A mural cliff runs along the north side of Mount Frederick, near the top (passable with difficulty in a few places). A sloping talus of *débris* from this cliff is wooded with a dense scrub containing some magnificent pines, besides too many specimens of the stinging-tree, one of which gave my assistant (MacKenzie) some trouble, and would have given him more but for the prompt application of ammonia.

Above the cliffs, on the slope before reaching the table-land on the top, the diorite weathers with a rough lumpy brecciforus surface. The angular lumps are also of diorite. These were doutless at one time breccias, like those of the adjacent Round Mountain.

On the northern slope of Mount Frederick three very remarkable rocky peaks stand up, their top reaches to or above the level of the table land. The highest is precipitous, standing sheer for say 300 feet on the south side, and much more on the north. I attempted to scale it for the purpose of making a plane-table survey from the top, but found that it would be impossible, at least without ropes or ladders. The peaks consist of a flesh-coloured porphyry of the same composition as Castle Hill, and many points of the Coast Range. They are evidently intrusive masses. In view of the frequent occurrence of gold in veins at the junction of porphyry or granite with diorite, I should like at some future time to examine the bases of the peaks and adjacent gullies. The plane-table and other *impedimenta* made this impossible at the time of my visit.

The middle peak of the three has a deep cavernous cleft near its base.

The low hills to the north-west of Charters Towers, which I have named Plant's Range, are also composed of diorite. In this case I am inclined to think the mass may possibly be intrusive. It occurs on the whole in the line of strike of the surrounding slates, the neighbouring stratified rocks being more quartzoze than is usual in the district. The slates and granite in the vicinity are pierced by a good many dykes of similar diorite. I have, however, found it impractible at present to distinguish on the maps between diorite and dolerite dykes, although the latter are probably of a much later (tertiary) age than the former. The angitic and the hornblendic rocks of this district are so similar in outward appearance that to separate them would involve a microscopic observation in each case.

As seen in microscopic sections, the diorite of Plant's Range consists chiefly of trichnic felspar interlaced with a network of minute needle-like crystals (*apatite*) and a fibrous green mineral understood to be hornblende, passing on the edges into serpentine. The rock also contains a good deal of iron pyrites and some magnetic iron.

A quartz reef, bearing north-west, is seen at the eastern end of the range near the road-metal quarry.

The diorite is quarried for road metal, much of it having been recently used near Millchester for road improvements, for which its toughness and durability make it peculiarly suitable.

The granites, syenites, and porphyries represent the highest degree of metamorphism observed in the district. They form the main mass of the Coast Range, and indeed of the high grounds generally.

To the granites belong Magnetic Island, the part of the Coast Range between Mount Frederick and Mount Black, together with the greater part of the gently undulating table-land from Thornton's Gap to Dotswood, the bank of the range drained by the heads of the Ross, Reid, and Haughton, much of the comparatively low-lying country at Charters Towers and Millchester, some of the pinnacles to the west of Towers Hill, the rolling downs between Towers Hill and the Pyramids or Seventy-mile Range, and some isolated masses in the Star district.

Charters Towers Hill best deserves the name of syenite.

The main masses of porphyry are Mount Stewart, Castle Hill, Mount Louisa, Mount Bohle, the range at the head of Running Creek (Star country), and the Pyramids or Seventy-mile Range.

Although presenting no very essential lithological difference, the granites and syenites on the one hand, and the porphyries on the other, yield to the influences of subaerial denudation in different manners and give rise to characteristic types of scenery.

The porphyry ranges are hard featured, and abound in bold escarpments and precipices. The rock is full of points, which divide it into sharp angular pieces.

The granites and syenites, on the contrary, have a more regular system of pointing, dividing the rocks, for the most part, into huge cubes and parallelopipedons. When in the course of denudation these are brought to the surface, they peel off in rudely concentric layers, the angles are softened, and the masses assume at length a rounded outline. The country occupied by granite and syenite is characterised by rolling downs, with occasional abrupt "towers" or peaks, like the "tors" of the forest of Dartmoor in England.

In spite of these distinguishing characteristics, which are noticeable on the large scale, no very sharp line can be drawn between the granites and porphyries on lithological grounds, as they merge into one another.

It appears most probable that the granites and porphyries were produced during one continuous period, the porphyries predominating towards its close, as porphyry dykes very frequently intersect not only the granite, but also the auriferous veins in granite country, and are even found cutting through the Upper Devonian rocks of the Star basin.

Copper and tin, in considerable quantities, have been obtained from the porphyritic rocks of the district north of the Burdekin.

On the east side of the Townsville road, near Dalrymple, opposite Mount Keelbottom, an east and west ridge of pale quartz porphyry, with clear quartz blebs in a highly silicated felspar matrix, is intersected at right angles by a vertical joint or vein. A shaft has been sunk on this vein and some valuable copper ore is said to have been raised. I have seen massive specimens of native copper and carbonates in the

the hands of gentlemen interested in the mine at the time when it was last worked. When I visited the place the shaft was standing nearly full of water, and I could only find some specimens of malachite (carbonate) and chrysocolla (hydrous silicate).

The Kennedy Copper Mine occurs on a ridge near Sandy Creek to the west of the Great Star River. The lode runs 35 degrees to the east of north, and two shafts have been sunk on it. From the southmost to the northmost shaft (distant about 100 yards) there is a gradual rise of about twenty feet.

About twelve feet to the south-east of the northmost shaft the lode forms a rock standing about six feet high.

A good many tons of valuable ore lie at the mouth of the shaft, chiefly aynrite (blue carbonate of copper), crystallised in rhombic prisms and pyramids and in radiating botryoidal masses, and malachite (green carbonate of copper). These crystallised ores must be almost chemically pure. Considerable quantities of the black protoxide (melaconite) and of the red oxide (cuprite) also occur, both mixed, especially the latter, with ferruginous earthy impurities. At the surface of the heap, and apparently last raised, is some copper pyrites.

The ridge in which the lode occurs is for the most part composed of a coarse grained quartz (porphyry). Probably a mass of stratified rocks occupied the same site before the intrusion of the porphyry. The lode occurs at the junction of the porphyry with the small portion of stratified rocks now left; but as the porphyry runs irregularly in and out of the stratified rocks, the country must be sometimes porphyry and sometimes shale or grit. The northmost shaft shows reddish shales and hard grits dipping at an angle of 45 degrees to the east, the southmost shaft similar rocks dipping at the same angle to the west, so that there is some probability that the lode occupies partly a fissure along the back of an anticlinal arch.

About twenty feet south-west from the outstanding ore-rock above referred to, a hole about six feet deep has been opened on the out-crop of the lode, and shows the following section (fig. 8):—

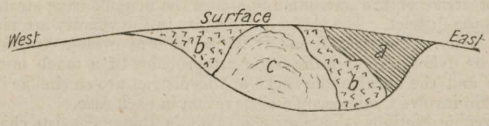


FIG. 8.—SECTION ON OUT-CROP OF LODE, KENNEDY COPPER MINE.

a Shales dipping at 15 degrees to east.

b Porphyry.

c "Gangue," chiefly of porphyry detritus and clay, coloured red by peroxide of iron, and containing malachite, azurite, cuprite, &c., apparently the top of a cavity in the porphyry, the gangue materials having a sort of dome-shaped arrangement.

The creek to the west of the lode shews (in a confused and interrupted section) alternations of porphyry with slates, shales, and siliceous grits, very similar to the country of the lode.

As the water was standing in the shafts, and the timbers had decayed, I was unable to go underground. From Mr. John Stone, manager of the Comstock reef, Charters Towers, formerly manager at the Kennedy Mine, I obtained in conversation the following particulars:—

"The ore occurred in a true lode averaging four feet wide. Carbonates predominated down to the sixty-five feet level. The next fifty feet or so were blank as far as ores were concerned. The next ten feet were occupied by sulphides. The water came in at this depth (125 feet) and the work was not carried much further."

Mr. F. H. Hackett, Mining surveyor, who inspected the workings, stated in a report, dated 25th May, 1875, that the lode underlies to the south-east at an angle of 25 degrees (from perpendicular), that the greater part of the ore (carbonates) was taken from a drive of fifty feet to the north-north-east of the northmost shaft at the ten fathom level. "That at a depth of twenty fathoms another level was driven in the same direction, about forty-two feet. This is somewhat below the water level, at which depth a great change in the character of the lode appeared to have taken place; the green and blue carbonite ores found from the surface to below the ten fathom level having given place to pure sulphuret ore."

In the Upper Star basin the "Great Northern" Copper Mine, said to be much richer than the "Kennedy," occurs in a band of slate running through granite. I have not yet had time to visit this mine.

Stream tin has been, till very recently, worked in the bed of Running Creek, at the south-west corner of the same range as that in which the Kennedy mine is situated. I traversed the range between the two mines, in the hope of finding the lode or dyke which may be presumed to be the source of the tin, but found only porphyry (coarse in grain with large round quartz blebs, and large crystals of orthoclase, occasional hornblende crystals, mica very rare), with the exception of one bar of slate striking east and west and dipping at a high angle to the north.

The workings occur at and below the junction of the two branches of Running Creek, after it has emerged from the mountains into comparatively low ground, with a surface of decomposing porphyry in which mica is a little more common than in the rock of the mountains. From the northern branch a trench or race dug in the gravel (which the next floods would obliterate) conducted a stream of water to a wooden sluice where the dirt was washed. The most recent workings at least had not been bottomed on the bed rock, but only comprised the upper four or five feet of the alluvial gravel. Two pans of this washdirt gave an average of three ounces to the dish.

Considering

Considering the hasty and unsystematic method employed—probably justified by want of capital—fair results seem to have been obtained; but the mines are in the meantime at a standstill, a quantity of tin awaiting transport to market.

The tin ore (cassiterrite) is in small, pretty well rounded grains, and appears to have travelled some distance, although prismatic crystals are still sometimes recognizable. It is mixed with small magnesia alumina garnets and yellow topazes.

The porphyry range of the Pyramids, or Seventy-mile, rises abruptly from the undulating plain of granite near the watershed between the Burdekin and the Cape Rivers. Alluvial was extensively worked in the gullies of the range and in the streams surrounding its base. On the discovery of Charters Towers field a rush took place there, and the Chinese occupied the abandoned Seventy-mile field in great numbers, to leave it on the break-out of the Palmer diggings. A little reefing had been done, but was stopped, as was till lately the fashion, on reaching the water-level and mundic. It is likely that reefing operations may be resumed in such a manner as to test the question of the continuance of the gold in the mundic.

A reef worked to the water-level by James Pyle (better known as Cornish Jim) has recently been taken up by Mr. John Swan and party. The reef lies on the north-west slope of a pyramidal mountain, and runs west 25 degrees south, underlying at 40 degrees to south 25 east.

The principal shaft, which the new holders had just begun to bale out, had struck the reef at a depth of 60 feet, having passed through a diorite dyke. Sinkings had been made in several places on the underlie along the outcrop of the reef. Samples from a "mullucky leader" of porphyry *débris* and decomposed pyrites ("brownstone") in one of these sinkings, are said to have occasionally yielded at the rate of 100 ounces of gold to the ton. I dug out two dishes of this, and obtained "colours" in both.

The brownstone is dark grey pyrrhotite or magnetic pyrites with sub-metallic lustre ($Fe_7 S_8$ = sulphur 39·5 + iron 60·5) coated with brown peroxide of iron. Berzelius and Rammelsberg (according to Dana) obtained $Fe_7 S_8$ by heating pyrites ($Fe S_2$). An analysis of the Seventy-mile pyrrhotite failed to reveal the presence of arsenic, copper, or nickel, although the latter is often present in magnetic pyrites.

On looking over the heap of old material at the surface, obtained from the "gangue," it was found to comprise fragments of diorite, quartz, and porphyry, all highly impregnated with pyrites, and pierced by strings of galena, weathering black on the outside. In a fragment showing a junction of diorite and porphyry, the line of contact is occupied by a thin vein of pyrites in minute crystals occasionally straited. Isolated crystals of pyrites are scattered through the diorite and porphyry, with the addition of marcasite in the latter. Other specimens of quartz and porphyry gangue show regular veins of galena associated with larger crystals of pyrites.

"Surfacing" operations have seamed the hillside up to the line of reef, but have stopped short there, the presumption being, that they ceased to pay at higher levels, the reef being, probably, the source of the greater part of the gold.

About 400 yards east of, and nearly in a line with Swan's reef, is another reef formerly worked by William ("Greasy Bill"). Its direction is west, 7° south. It hades about 45 degrees to south 7° east. The reef, which is mainly angular *débris* of porphyry, containing quartz with pyrites, and red oxide of iron, is about four feet wide. Some of the "brownstone" from the surface is said to have gone thirteen ounces to the ton, but the workings were stopped on reaching the mundic. A quantity of mundic lies around the shaft.

About twelve feet below this reef, another two feet in width occurs, containing a good deal of pyritous quartz.

The quartz from the bottom of the shaft is white, and contains a good deal of pyrites and some zinc blende.

A tunnel was driven some thirty feet into the hill by Pyle, about 300 yards south of Swan's reef. No reef appears to have been followed, the tunnel having been driven simply into the decomposed porphyry, the softer and more ferruginous parts (possibly so from the decomposition of auriferous pyrites) in the neighbourhood of joints being taken out. It is a porphyry with reddish blebs of quartz in a buff matrix of decomposed felspar. This stuff is said to have crushed two ounces to the ton, the gold being in fine threads, a peculiarity of gold much alloyed with silver.

The experience of the Charters Towers field having proved that the gold continues in the mundic as well as in the "brownstone," the Seventy-mile may yet deserve the attention of reefers. All the creeks surrounding the mountain on which "Swan's" and "Greasy Bill's" reefs are situated, having proved rich in alluvial gold, search is being made for reefs by surface trenching and otherwise.

Comstock, or Stockholm Reef.—This, one of the "outside" reefs of Charters Towers, occurs in porphyry "country" (matrix of silicated felspar, with large blebs of quartz), near the junction of the porphyry with the slate. The reef is about five feet wide, with an indistinct footwall. The hade is steep, about 75 degrees to east, 25 degrees north. The present workings have reached 135 feet on the underlie. The "ore" now being raised is a good-looking dark-blue mundic stone, said to be occasionally four to six feet wide. It contains a large percentage of zinc blende, a good deal of iron pyrites in minute crystals, a little copper pyrites, and some galena. In one place, at the surface of the reef, carbonate of copper is seen. There have been no crushings from this reef since the present company took possession. The last crushing of the previous company gave from half-an-ounce to sixteen pennyweights. Some of the stone assayed by Mr. T. Buckland contained gold at the rate of nine to ten ounces to the ton.

Mr.

Mr. Stone, the manager, explained as a peculiarity characteristic of this reef, that the shoots of quartz are apt to come down the middle of the reef, and on touching the hanging wall, to make a "splice," and return to the footwall, as in the diagram. (*Fig.* 11.)

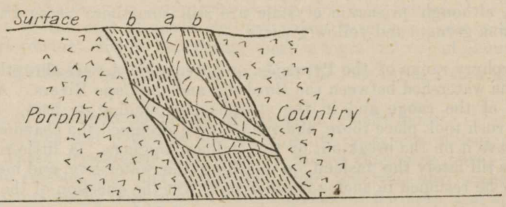


FIG. 11.—DIAGRAM SHOWING CHARACTERISTIC "SPLICES" IN COMSTOCK REEF.

a. Quartz with mundic.
b. Mulluck.

Two other reefs adjoin the Comstock to the east, the first bearing south 35 degrees east, and hading at 65 degrees east to 35 north, and the second bearing south 5 degrees west, and hading east 5 degrees south. Both have been worked a little on the outcrop, in the brownstone.

Old Warrior Reef.—This is another of the "outside" reefs of the Towers field. It occurs in a prophyry country on the west side of a group situated two miles south of Millchester, comprising the Alexandra, Pacific, Washington, Sons of Freedom, Imperial, and others. It strikes W.S.W., and hades at 33 degrees to the N.N.W. In the only claim at present working the mundic has not yet been reached. The brownstone yields 3 to 9 dwts. Claims on the east side of the road used to give 15 dwts. The reef is about two feet wide, and contains a good deal of selemite. The best gold is said to come from the vicinity of the footwall.

Imperial Reef.—This reef lies to the south-east of the Old Warrior, and has nearly the same bearings. It shows a great breadth of quartz at surface, and is said to have four feet of stone below as a rule. There is a heavy influx of water, requiring constant pumping with an engine. A five-stamp battery has recently been erected. The following section is seen at the surface:—

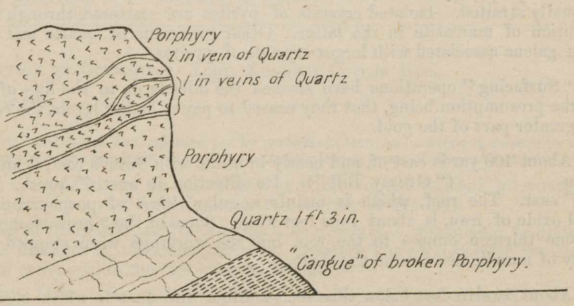


FIG. 12.—SECTION OF SURFACE OF IMPERIAL REEF.

A large reef crosses the Bluff track, to the south-west of the Imperial. It is traceable for a considerable distance from west-north-west to east-south-east as a wide vein of quartz, sometimes crystallised. It has been opened out a good deal on its outcrop, and some trial crushings have been made, which are said not to have been very encouraging.

As a specimen of the typical porphyry, I have examined with the microscope a prepared section of the rock of Melton Hill, Townsville. It has a pale pink or flesh-coloured matrix of silicated felspar, with crystals of orthoclose and quartz. Mica is very rare, hornblende more common; but neither occur so frequently as to be reckoned an essential mineral.

On this hill, at the south-west corner of the Custom House, a little vein of iron pyrites is exposed in the road cutting.

The rich goldfield of Charters Towers occupies the western edge of an area of granite and syenite bordering on the little altered slates and grits of the Sandy Creek district. It was discovered in 1872 by Messrs. H. Mosman, C. E. Clarke, and J. Frazer, who left the Seventy-mile field to prospect the distant Towers. The first claim was laid off on the 25th March, 1872, and the district, including an area of 1,700 square miles, was proclaimed a goldfield on 31st August of that year.

A typical specimen of the granite of the district (from the country of the Old Identity reef) examined under the microscope shows crystals of orthoclose felspar, mica, quartz with fluid cavities, and some hornblende. Also much iron pyrites in minute cubes disseminated through the mass, and often in the middle of felspar crystals, surrounded by a green ring (coloured by protoxide of iron). Chlorite is also abundant, coating joints and filling up spaces between crystals.

Another specimen from the well beside the residence of Mr. Dicken, Police Magistrate, has a matrix of cream-coloured felspar in which are disseminated crystals of orthoclose quartz with fluid cavities, mica (biotite), hornblende, and chlorite; also iron pyrites and some (microscopic) garnets.

In the rock of Charters Towers Hill mica is rare and hornblende abundant. The rock is, therefore, rather syenite than granite.

The

The following diagram (fig. 15), which shows the directions of the various reefs, with their underlie sides, will save many pages of description :—

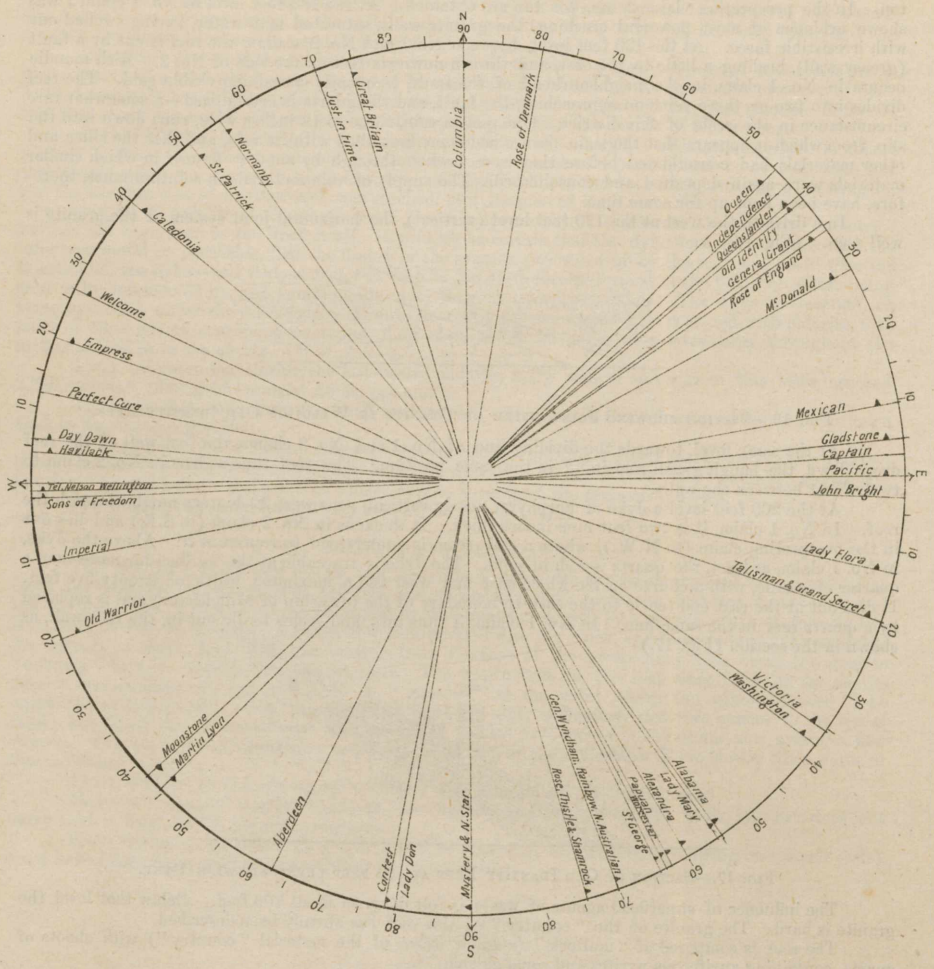


FIG. 15.—CHARTERS TOWERS REEFS, SHEWING BEARINGS AND UNDERLIE.

N.B.—The black triangle is placed on the underlie side.

It is only when the reefs have been laid down on the map that it becomes apparent that they follow a definite system. They form a sort of horse-shoe bend, with its convex side to the south, and underlie towards the centre of this curve at a low angle. It will be worth while to make some inquiry into the meaning of this circumstance, after having noted some of the peculiarities of the reefs.

At the present day visible gold is a rarity in the reefs; but experience having shown what classes of stone yield most when crushed, the miner is in no way disturbed even if he never sees "the colour" in his workings.

I visited a number of the principal reefs. To examine them all would have taken much more time than was contemplated in my instructions, which were to pay a "flying visit." There is, besides, a considerable monotony in the underground operations, which present the same "country," the same "gangue," and the same phenomena at and above the water level. Moreover, a single inspection often reveals next to nothing, for it is not in any way instructive to see a hole from which a fine shoot of stone may have been taken the previous year, or twenty yards of close timbering said to conceal some interesting leaders or cross courses. Those who are on the spot enjoy opportunities of observing important facts as the works progress.

It would be highly desirable that miners and managers should hold frequent meetings for the relation and discussion of points which strike them from time to time. The presence among them of some persons of reading and experience would enable them to see the bearing of the observations, and their records would probably result in pecuniary as well as in scientific gain. As it is, many valuable observations are recorded in the Warden's and Commissioner's Reports and in the local newspapers.

Old

Old Identity Reef.—The Old Identity reef underlies to the north-west at thirty degrees. It varies from a few inches in width to four feet, the gangue being quartz with some carbonate of lime and some pyrites, also a little bismuth. Barytes occurs on joints in the granite walls. In No. 1 claim the shaft struck the reef at sixty feet deep, from which level 130 tons crushed at the rate of 4 ozs. 8 dwts. to the ton. In the prospecting claim 2 ozs. per ton are obtained. At the 130 feet level in No. 1 claim I was shown evidence of most powerful crushing, the granite walls, saturated with water, having swelled out with irresistible force. At the 130 feet level, between No. 1 and No. 2 claims, the reef is cut by a fault (greasy wall), heading a little to the east, and thrown down six feet on the side of No. 2. Rich mundic occurs in No. 1 claim, in the neighbourhood of the fault, frequently containing visible gold. The reef divides into two or three veins on approaching the fault, and the quartz is crystallized—a somewhat rare circumstance in the reefs of this district. One quartz vein, three to 12 inches wide, runs down into the slip, from which it appears that the main fissure had been first filled with its vein, and that the silica and other materials had consolidated before they were broken through by another fissure in which similar materials were again deposited and consolidated. The supply of vein materials in solution must, therefore, have been kept up for some time.

In a drive to the west at the 120 feet level (vertical), the horizontal joint system of the granite is well seen. (Fig. 16.)

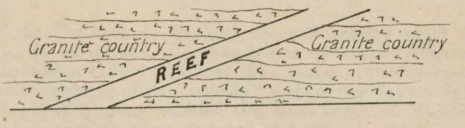


Fig. 16.—Section showing Joint-system of Granite in Walls of Old Identity Reef.

At the same level, towards the dividing line of No. 1 and No. 2 claims, the foot wall of the reef drops down, the hanging wall remaining in the same position. The reef thus widens in No. 2 claim to twelve feet between the walls.

At the 200 feet level a dyke of porphyry, nearly vertical, runs west 20 degrees north, through the reef. In No. 1 claim, it is two feet nine inches thick. It thickens in No. 2 claim (to S.E.) and dies out in the prospecting claim (to N.W.), where a clay seam is understood to represent it. Above the dyke, in No. 1 claim, at least, the quartz is rich in gold. The dyke is traceable at the surface for more than a quarter of a mile, with a course on the whole east and west and a maximum width of twenty-five feet. It dies out at the east end (close to the eastern boundary of the township of Millchester) and is replaced by a quartz reef in the same line. In No. 1 claim, it runs into, and seems to die out in, the foot-wall, as shown in the section (Fig. 17.)

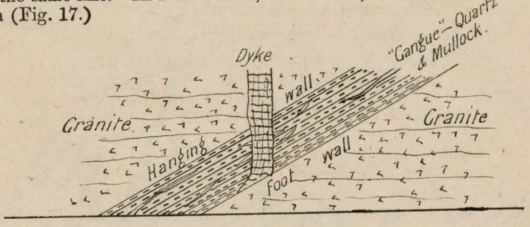


Fig. 17.—Section of Old Identity Reef at 200 feet level, shewing Dyke.

The influence of superficial agents of waste is felt down to about 100 feet. Below that level the granite is hard. The granite of the "country" of this reef has already been described.

The reef is composed of "mullock" (angular *débris* of the material "country") with shoots of quartz, containing auriferous pyrites and some galena.

The shoots of quartz are said to run down the reef diagonally from south-west to north-east.

Queen Reef.—Another reef among the most important on the field is the Queen, situated between Millchester and Charters Towers. Under the guidance of the manager, Mr. Cooper, I visited the workings in No. 136 lease (Bryan O'Lynn). This reef bears N.E. and S.W., with an underlie of thirty degrees to the north-west. This bearing is quite abnormal in the field—in fact, the "Queen" may be said to be a cross-course, situated as it is in the middle of a cluster of reefs bearing north-west and south-east and underlying to the north-east.

In this lease a vertical shaft cuts the reef at a depth of 208 feet. At that depth a level was driven from the shaft 340 feet to the south-west, through soft "mullock" (broken granite), between well-defined walls. Quartz veins come in and die out in the gangue with apparently no regular system. Specimens of what is considered "two-ounce stone," taken from the south-west corner of the lease at this level, are of compact quartz, with joints and sides coated with chlorite and pretty well darkened throughout with galena and iron pyrites.

Sometimes the ores occur alternately in little veins or strings, sometimes in isolated aggregations, while at other times the crystals of both are indiscriminately mixed. The quartz has the bluish tinge (due to silicate of lead ?) which is, rightly or wrongly, believed on the field to distinguish auriferous from "buck" quartz.

Specimens picked out by Mr. Cooper as examples of stone which he estimated at "one and a-half ounces" and "better than two ounces" respectively, differ from the last-described specimens, the former in having quartz of a lighter blue, veined with felspar, less galena, and more steatite; the latter in having both the galena and the pyrites in finer crystals disseminated indiscriminately throughout. Other specimens from this level contain a little gypsum. In some sphalerite (zinc-blende) galena and iron pyrites are associated.

A few

A few specimens containing visible gold were presented to me by Mr. Cooper. One of these is part of a vein about one inch in width, coated on both sides with chlorite and coloured dark-blue with minute crystals of galena. Some specks of gold occur in the middle of a mass of crystallized zinc-blende. The quartz is amorphous except in the middle, where both sides of an open cleft are lined with dog-tooth crystals, the spaces between the crystals being filled up with gold.

In another specimen the gold occurs as an isolated cluster of grains in a mass of milk-white amorphous quartz, of a kind which would be apt to be regarded as "buck" but for the visible presence of gold. A third specimen has gold in scattered grains among crystals of pyrites and very fine galena. A fourth specimen shows a mass of gold containing minute pyrites crystals in a matrix of white quartz.

In the "Queen," generally, the quartz veins penetrate the foot wall, a circumstance which is almost peculiar to this reef, and was understood to indicate the presence of a parallel reef below. A drive was accordingly made bearing south-south-east from the end from the 340 feet long level above referred to, and the hanging wall of another reef was reached, at a distance of sixty-three feet.

A dyke of porphyry, or perhaps more properly syenite, runs south-east through the "country," but has not been seen in the reef itself. Could we be certain that the dyke does not cut the reef the inference would be justifiable, that the fissure in the granite, now filled up by the reef, was made *after* the injection of the dyke—and that, in fact, this reef is one of the latest formed in the field, the others being as a rule, intersected by, and consequently older than the porphyry dykes. The dyke in question, on being examined under the microscope, shews a matrix of felspar a good deal coloured with chlorite, with blebs of clear quartz containing numerous fluid cavities. Small cubes of pyrites occur throughout the matrix as well as in the quartz.

I was informed that during the last twelve months, 2,273 tons of stone from this lease crushed 2,286 ounces.* The gold averaged £3 5s. per ounce.

The water that soaks down the shaft is quite salt. The same is true of some of the wells in town sunk in decomposed granite.

In claims No. 1 and 2 (Mr. Marshall, manager), the granite is decomposed down to the 100 feet level. At this level the hanging wall first becomes distinct. There is very little "mundic" above this, but only "brownstone." Indeed this remark applies to most of the reefs on the field.

The prospecting claim proved very rich at the 180 feet level.

SAINT PATRICK BLOCK.

This reef has a north-west course, and underlies to the north-east at an angle of 28 degrees. The block has a vertical engine shaft of 110 feet, and an underlie shaft measuring 580 feet from the foot of the vertical shaft. I descended (accompanied by Mr. Scott, manager) by a vertical shaft of seventy-two feet, sunk on the old prospecting claim, now incorporated with the block, and then followed the underlie. For seventy or eighty feet down the underlie from the foot of the prospecting claim shaft the granite "country" is soft, reddish, and decomposed. The brownstone in the reef went down as far as the granite was decomposed, and gave place to "mundic" at the point where the granite ceased to be influenced by weathering. The "brownstone" here was only moderately rich, two ounces to the ton at most; but where the "mundic" was first struck it yielded five ounces. The stone now averages two ounces. The workings now reach the north-east boundary on the underlie. There is very little water in the workings.

At the 350 feet level I saw a reef of quartz with "mundic" six feet in width.

There is "mundic" in the "mullack," or broken granite between the walls, but this does not carry gold, at least, not in payable quantities.

From the following sketch (Fig. 19), it will be seen that disturbances (faulting on a small scale) must have taken place within the reef after its consolidation.

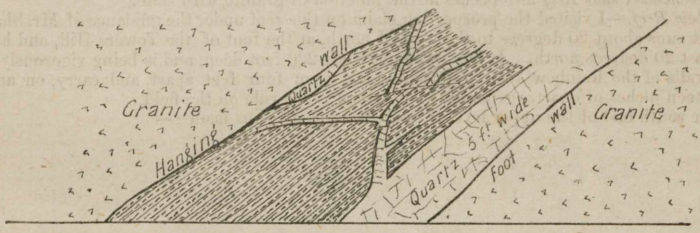


Fig. 19.—Sketch 10 Feet below 300 Feet level St. Patrick Block, showing Small Faults in Interior of Reef.

At the north-west boundary of the block the reef rises in a curve, the underlie being even for a short space reversed.

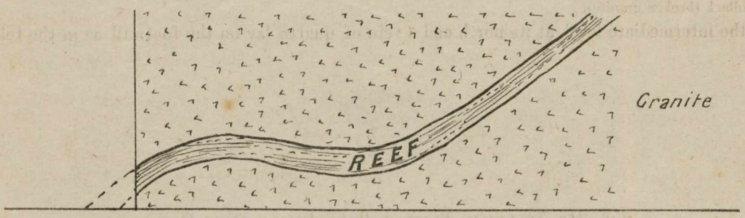


Fig. 20.—Section shewing "Pitch" in St. Patrick Reef.

In

* A crushing of 350 tons since the date of my visit yielded 350 ounces.

In the roof, at the top of the curve in Fig. 20, a slip cuts off a vein of quartz, but the reef is not cut out, two feet of mullack lying between distinct walls.

The following section (Fig. 21) was sketched at the 450 feet level:—

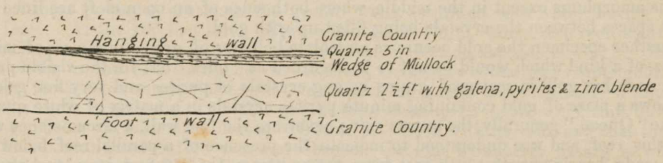


FIG. 21.—SECTION AT 450 FEET LEVEL, ST. PATRICK REEF, LOOKING TOWARDS THE RISE.

At this level I observed occasional veins of selemite an inch or two in width in the middle of the reef.

At the south-east end of the 450 feet level, an instructive section showed a good "mundic reef," side by side with a "buck reef." Such an experience may be accepted as a warning that, although a reef may happen to present at its outcrop nothing but "buck stone," the whole reef is not necessarily of that character.

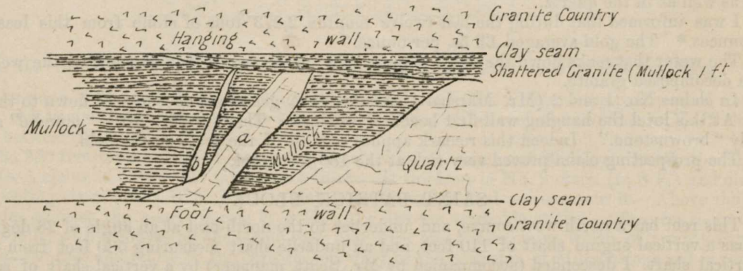


FIG. 22.—SECTION AT S.E. END OF 450 FEET LEVEL.

a. Streaky dark-blue quartz, with galena and pyrites. (Good.)

b. Poor white quartz. ("Buck reef.")

St. Patrick Reef.—The St. Patrick has proved one of the richest reefs in the field, and is distinguished by an unusual width of gangue.

The Mexican Reef, not only cuts through the granite, but also intersects, nearly at right angles, a band of slate three to four feet wide. The reef is sometimes as much as fifteen feet wide. The workings are now in the "mundic," at a depth of 250 feet, and are found to be richer than in the "brownstone." A recent crushing gave 2oz. 7dwts. The gold is said to be finer in grain in the "mundic" than it was in the "brownstone."

The best stone is a dark mixture of quartz and slaty *débris*, the quartz containing specks of galena and some pyrites.

The Same-as-Usual Reef also occurs at the junction of granite with slate.

Rainbow Reef.—I visited the prospecting claim on this reef under the guidance of Mr. Shakespeare, manager. It runs about 20 degrees to the west of north, at the foot of the Towers Hill, and hades at 38 degrees to east 20 degrees north. It has an engine shaft 220 feet deep, and is being vigorously worked.

The walls of the Rainbow reef are usually less than four feet apart, and carry, on an average, twelve to fifteen inches of quartz, generally whiter than is the rule on the field.

At the south end of the upper level the following sketch was made:—

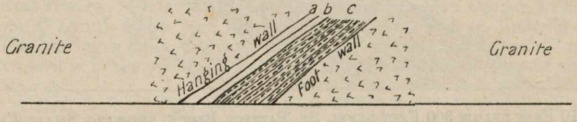


FIG 23.—SKETCH IN RAINBOW REEF AT UPPER LEVEL.

a. Quartz vein with rich mundic.

b. Quartz vein with no mundic.

c. Mullack (broken granite).

In the intermediate level at its north end a vein of quartz lay on the footwall as in the following sketch:—

FIG. 24.—SKETCH IN RAINBOW REEF, INTERMEDIATE LEVEL.

a. Mullack (broken granite).

b. Quartz vein, 1 foot.

The

The quartz veins contain good "mundic." The mullock also contained "mundic" in the vicinity of the reef, but not good enough to crush.

An east and west diorite dyke cuts the reef, but in the manager's opinion does not influence its bearing qualities. A slip shifts the reef to the extent of eighteen feet.

A specimen from the Rainbow reef presented to me by Mr. J. J. MacDonald, shows fine gold in a matrix of white quartz; one large and a group of small pyrites crystals occur near, but not in contact with the gold.

North Australian Reef.—The North Australian reef has a course nearly parallel to that of the Rainbow reef with an underlie of 47 degrees to the north-north-east, and penetrates both the syenite "country" of the Towers Hill and the granite country to the north-west. In No. 3 claim (Mr. Steward, manager), a depth of 350 feet has been reached at the boundary of the claim.

The reef varies from one foot to four and a-half feet in width.

At the date of my visit the quartz vein in the reef was eight inches wide.

The "mundic" stone of this reef appears to be richer in galena than most of the others in the field. The last crushing (of 360 tons) gave three ounces to the ton.

A perpendicular dyke of diorite, five feet in width, running east 15° south, cuts the reef and is believed by the manager to affect favourably the auriferous character of the mundic. There was very good stone (three and a-half to four ounces) above the dyke at the 235 feet level. Veins of gypsum occur on the sides of the dyke.

Newton Butler Reef.—This reef lies about a mile and a half south of the "Comstock," in granite country. It was opened by James Pyle, abandoned, and recently re-opened. It is still in the "brownstone." The present owners have crushed as low as 18 dwts., and as high as 2½ ounces to the ton.

Warden Reefs.—As this reefing district, on the north of the Broughton, 5 miles from Charters Towers, has recently been opened up, and as it is beyond the limits of the large scale map, the following sketch is introduced to shew the positions of the reefs:—

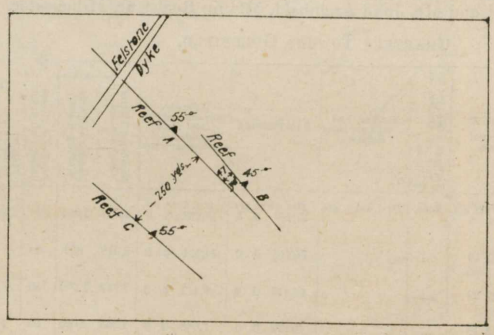


Fig. 25.—Sketch Plan of Warden Reefs.

Reef A is down 30 feet in the brownstone. A trial crushing from the upper part of the shaft gave 4 ounces to the ton. A little carbonate of copper is visible in the brownstone. The reef averages 1 foot wide.

Reef B was just being opened up from the surface at the time of my visit. It averages 2 feet 6 inches wide, and contains a little pyrrhotite. As this mineral occurs in a fresher condition than is usual in the "brownstone," it is possible that the weathering of this reef does not reach the customary depth, and that the "brownstone" may shortly be expected to give place to "mundic."

Notes on several of the other reefs on the field will be found in the maps. I hope to have ere long an opportunity of spending more time in the workings than I have yet been able to do.

It appears to be undeniable that in the Charters Towers Goldfield, as in other auriferous pyrites regions, it is to a certain extent true that the surface of a reef is sometimes exceptionally rich in gold. The region of "brownstone," or pyrrhotite and peroxide of iron, coincides with that superficial part of the rock which is not permanently saturated with water, and into which the atmosphere penetrates. A second region, that of "mundic," or auriferous sulphides, is co-extensive (so far as is yet known) with the zone of permanent saturation. The rainfall is understood to circulate "chiefly within a film of the rocky crust not much exceeding 2,000 or 2,500 feet."*

As, however, the lower limit of saturation must vary according to the compactness of the rock and the weight of the water, it may be accepted as certain that the above is an over-estimate for a district of small rainfalls and hard granite rocks.

In the progress of denudation, the upper zone, which may be called the "zone of intermittent saturation," must necessarily invade the lower zone, that of "permanent saturation," while the lower limit of the latter will sink deeper and deeper into the crust of the earth.

The "brownstone" is "mundic" which has undergone oxidation, the pyrites being altered to pyrrhotite—a change similar to that which can be produced artificially, as in the experiments of Rammelsberg and Berzelius, above referred to. As, however, there is no reason to doubt that the gold exists in the "mundic stone," it seems difficult to account for its greater abundance in the superficial brownstone.

The

* Page's Economic Geology.

The simple explanation suggested by Mr. Belb, however, meets all the requirements of the case:—On the denudation and oxidation of the upper portion of a reef the gold mixed with the denuded sulphides is set free, and is carried with the aid of rains and by virtue of its own high specific gravity into the porous weathered upper part of the reef which is next in turn to undergo denudation; and it may thus happen that the "capping" of a reef is enriched with loose gold. Add to this that the working of the surface is much easier than that of the deep levels, and it will be at once seen how, in many cases, only the upper part of a reef may be payable.

Gold disseminated through the granite rocks themselves is occasionally evident to the naked eye, but it may readily be believed that it may be present in many cases in quantities so small that neither the microscope nor ordinary analysis will detect it That it has been collected in veins from the granite rocks, by means of lixiviation, is rendered very probable from the fact of the auriferous pyrites occurring in the "zone of permanent saturation."

From an examination of specimens containing visible gold, I am inclined to think that the gold is not in chemical combination with the pyrites or the galena, but either exists in these minerals as an impurity, or has been rejected from them on their crystallization. The property of substances on their crystalization to throw out foreign bodies is well known, many important metallurgical processes being based on it. At the same time the microscope has made evident, as analysis had already shown, that a chemically pure mineral is a rarity in nature.

Arsenic is scarcely known in any form in the field. I detected this metal, however, in stalactitic carbonate of lime from the surface of a reef in the line of the "Captain."

A good deal of "surfacing" has been done on the field at one time or other. One party was engaged in December in stripping surface from the flat between the "Moonstone" and "Welcome" reefs. The surface, on being "tommed" at Sandy Creek, about a mile distant, yielded 1 dwt. to the load.

With the view of showing the progress of the goldfield, and comparing its yield of gold one year with another, I have thrown into a tabular form the information contained in the Warden's annual report and other documents, the particulars having been supplied by the kindness of Mr. G. L. Lukin, Under-Secretary for Mines, and Mr. John Archibald, Mining Registrar, Millchester.

CHARTERS TOWERS GOLDFIELD.

Year.	Stone Crushed.	Yield of Gold from Crushing.	Average of Gold per Ton of Stone.	Tailings treated per return of Owners of Works.	Yield of Gold tailings per same Return.	Gold Escorted.	Difference between yield of Gold from Crushing and amount escorted.	Number of Miners' Rights issued	Number of Miners working Quartz.	Number of Miners working Alluvium.	Number of: Quartz Crushing Machines.	Number of: Heads of Stampers.	Number of Steam Winding and Pumping Machines.	Number of Horse Whims.	Greatest depth of payable Gold.	Greatest depth of any Vertical Shaft.
	Tons.	Ozs. dwts. grs.	Ozs. dwts. grs.	Tons.	Ozs. dwts. grs.	Ozs. dwts. grs.	Ozs. dwts. grs.								feet.	feet.
1872	12,054	20,063 19 5	1 14 5			31,287 2 5	11,223 3 0	2,303	2,000	800	6	79	...	...	50	120
1873	37,937	59,835 0 0	1 11 13	...	...	74,746 0 0	14,911 0 0	2,418	850	50	?	84	10	8	75	120
1874	33,097	52,872 14 21	1 11 23	...	...	62,345 0 0	9,472 5 3	1,717	1,200	50	?	94	8	6	150	150
1875	36,876	62,214 0 0	1 13 17	...	...	69,277 0 0	7,063 0 0	1,359	1,030	30	7	93	?	10	226	225
1876	37,500	58,068 2 10	1 10 23	1,525	779 0 0	67,615 0 0	9,546 17 14	1,224	1,140	130	9	104	20	26	250	230
1877	36,030	66,479 3 16	1 16 22	2,978	1,799 14 0	87,200 14 20	20,721 10 4	1,286	1,100	20	11	123	13	29	420	240

It appears from the above figures that (excepting the first year, 1872, which includes only a few months) the annual quantity of stone crushed, and the amount of gold produced have been practically the same, the last year (1877) showing the best return of gold since the opening of the field. Steady employment seems to have been afforded by the reefs for about 1,100 men. So far, therefore, as experience goes, there is nothing to indicate a falling off in the production, or even (in spite of some exceptionally rich "finds" in the "brownstone") any serious average difference between the yield of the mundic and "brownstone." (For the first year or two it will be understood that the workings were mostly in "brownstone," and for the remaining years mostly in the mundic.) Taking into account the increased difficulty of extracting the gold from the mundic, the difference, if any, would appear to be rather in favour of the latter.

There is no reason to expect any material change in the nature of the reefs within the limits of the zone which the workings have now almost all reached, viz., that of "permanent saturation," unless it be, perhaps, an increase in the quantities of heavy metals or ores—gold, silver, sulphides of iron, and perhaps of copper.* Whether the source of the gold, &c., in the reefs was the adjacent "country," or whether the metals and ores were derived from below, the heavy precipitates from their solutions would tend to be deposited in the lower parts of the fissures more than in the higher. I do not mean to predict that every reef in the field will prove richer below than above, but the observation, I am firmly convinced, will be true of the field as a whole.

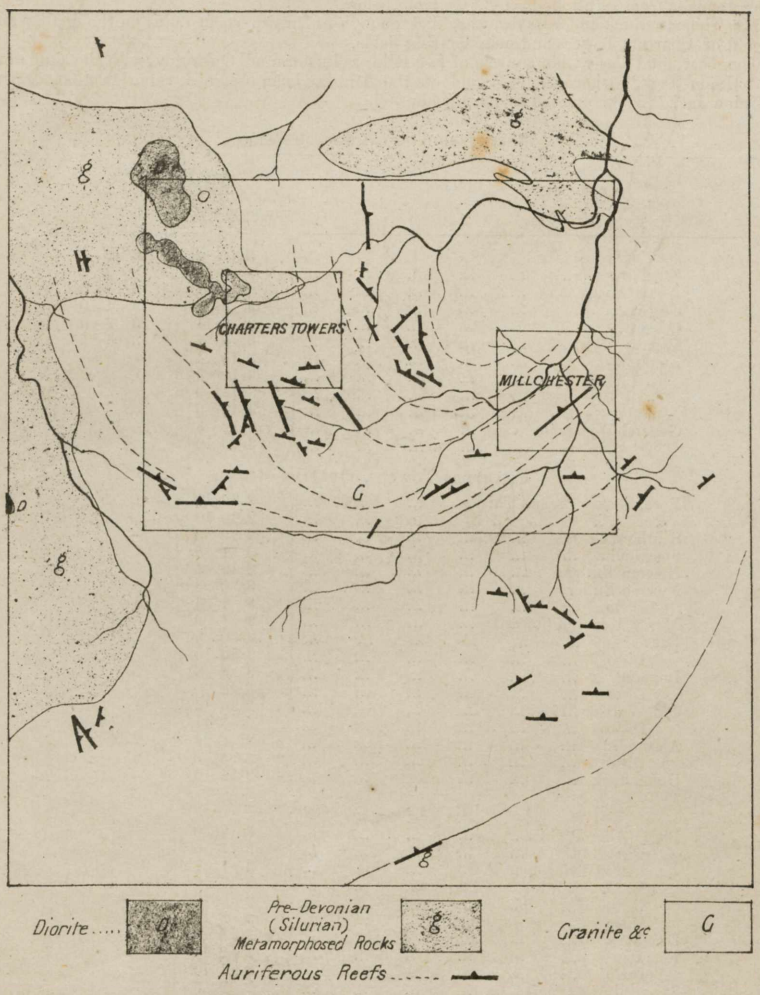
Admitting that granite rocks in a region of low rainfall may not be permanently saturated below 2,000 feet, it will be seen from the table that the workings at Charters Towers have hardly yet reached more than a fifth of this depth. It must, therefore, be some time before the question of the continuance of the gold below the limit of "permanent saturation" can be put to the test.

It is true that the difficulty and cost of the workings must increase with the increasing depth, but on the other hand there is to be set against this the inevitable cheapening of materials, carriage, labour, and cost of living, which must follow the natural increase of population, as well as the gain from improvements in the method of treating pyritous tailings, and the utilisation of the abundant lead ore associated

* Carbonates and sulphides of copper occur, though rarely, in the field.

associated with the gold. Taking all these into account, it will probably be a very long time before the gold will not pay for working.

The "horse-shoe" arrangement of the principal reefs has already been alluded to. The diagram-map (fig. 26) permits of this being seen at a glance.



The black triangle indicating the side of underlie.

FIG. 26.—DIAGRAM-MAP, SHOWING CONCENTRIC ARRANGEMENT OF THE PRINCIPAL REEFS ON THE CHARTER TOWERS GOLDFIELD.

From this diagram it will be readily understood that an important group of the principal reefs in the field ought, if they continue in depth, to converge at some point within the horseshoe bend, in a manner which may be best placed before the mind of the reader by supposing a number of chemical "funnels" (without the pipes) to be "cased" one within the other. The reef fissures may be a series of faults due to the subsidence of a mass of the earth's crust into a subterranean cavity. (Such a cavity might result either from the extension of a deep-seated mass of melted rock by a volcano, or from the slow solution and removal of a subterranean mass by springs.) Or a temporary swelling of the earth's crust, say from the generation of steam beneath it, might produce a set of concentric faults. Or, finally, it is possible that a single earthquake shock might produce concentric fissures along the circles of emergence of the earthquake wave.

These fissures, if protracted beneath the surface, would converge along a vertical line—the "axis of elevation," "centre of depression," or "seismic vertical," according to the theory adopted for the cause of the fractures. This line, in the case of the group of reefs referred to, may be expected to lie to the north of Millchester, probably between the township and Mosman's Creek. The upper reefs ("Old Identity," "Just-in-Time," &c.,) may reach it at a depth of perhaps a mile. It is not to be expected that those reefs will ever be worked down to this depth, still less that the underlying and more distant reefs will be worked till they impinge upon the imaginary vertical line; but it may reasonably be expected that as they approach nearer to the centre of disturbance, they will prove richer in metallic deposits. The region between

between Millchester and Mosman's Creek, as being directly over the focus of disturbance, may also be pointed out, theoretically, as one where reefs may be expected to prove exceptionally numerous, and perhaps exceptionally rich. The force of an earthquake shock, and consequently the chance of fracturing the rocks, is, of course, greatest above the seismic vertical. The seismic vertical is also, of course, the shortest line from the focus to the earth's crust, and a fissure at or near it would have the best chance of receiving deposits from solutions brought up from below.

Mr. Thomas Buckland, assayer, was kind enough to furnish some notes on the quality and value of the gold of Charters Towers and neighbouring fields.

The best gold lies within a circle of two miles radius around Queenton, with the single exception of the "Union Jack," where the best gold on the field has been obtained, value £3 15s. 6d. per ounce. The "Union Jack" is surrounded by poor gold.

CHARTERS TOWERS, INSIDE REEFS.

Reef.	Mint Value of gold. In Brownstone.			In Mundic.		
	£	s.	d.	£	s.	d.
St. Patrick	3	9	2	3	5	2
North Australian	3	13	1	3	10	0
Just-in-Time	3	9	8	3	4	10
Queen	3	9	11	3	7	0
Papuan	3	8	7	3	5	7
Rainbow	3	14	4			
"	3	10	5			
"	3	11	0			
"	3	12	6			
General Wyndham	3	12	3			
"	3	13	10			

CHARTERS TOWERS, OUTSIDE REEFS.

Rose, Shamrock, and Thistle	2	16	11
" " "	2	15	10
Southern Cross	2	19	2
Stockholm	3	1	5
Newton Butler	2	19	4
Newton Butler	3	0	3
Ditto	3	1	3
Merry Monarch (lowest)	3	1	8
Puzzler	3	0	6
Ditto	2	19	10
Imperial	3	6	8
Ditto	3	2	0
Old Warrior	3	0	5
Ditto	3	5	11
Alexandra	3	6	8
Ditto	3	5	3
Union Jack	3	15	6

REEFS AT A DISTANCE.

Bluff (Alice P. C.)	3	2	0
Ditto (ditto)	2	17	6
Ditto (Livingstone P. C.)	2	7	7
Ditto (ditto)	2	17	6
Ditto	2	19	9
Ditto	2	8	10
Dreghorn	3	18	6
Rochfort	3	2	11
Ditto	3	1	10
Seventy-Mile (Reef)	2	17	6
Ditto (ditto)	2	14	6
Ditto (Pyle's Reef)	2	14	10

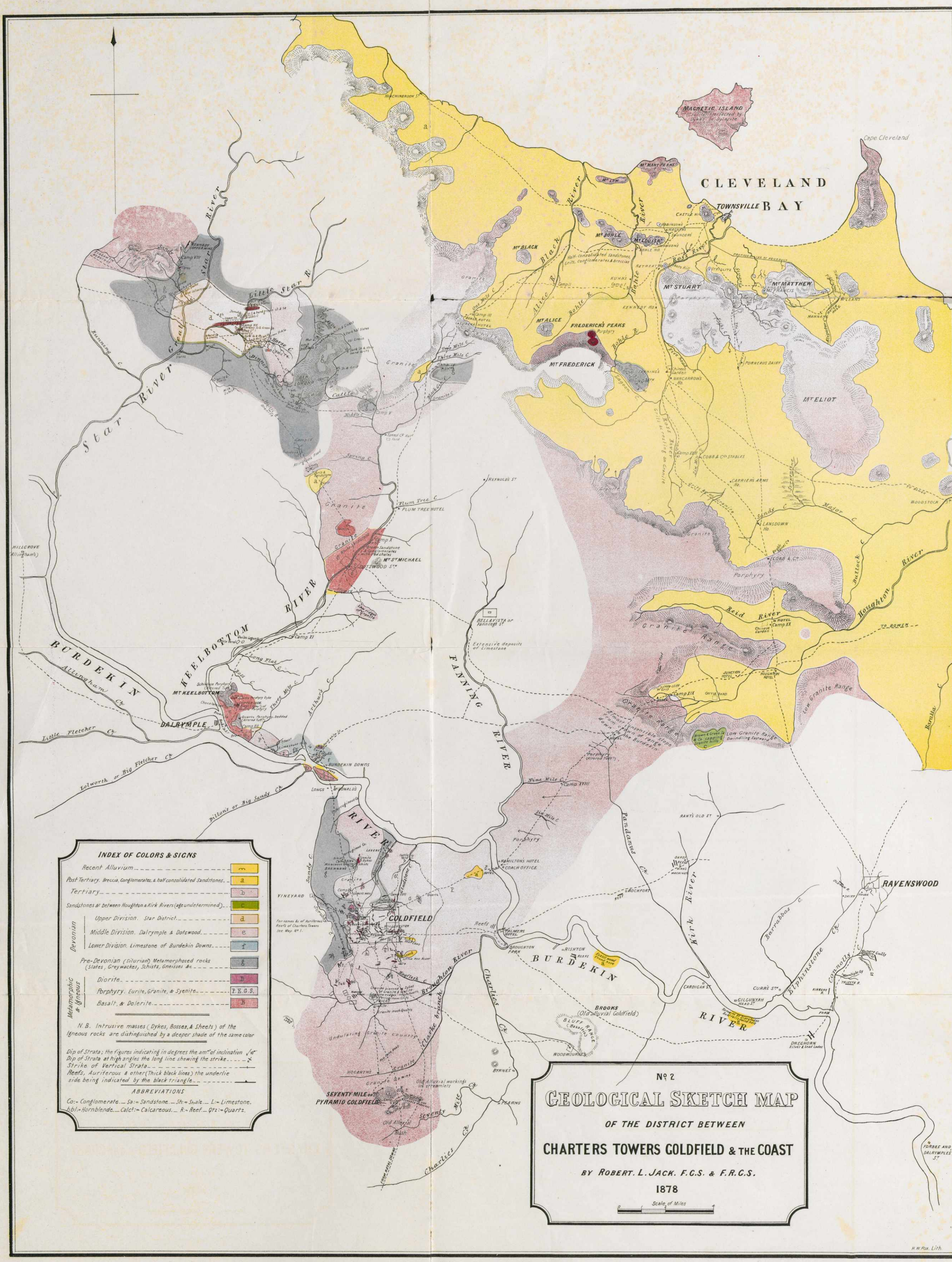
	Full Values.		
Ditto Alluvial, heavy nuggety	3	13	4
Brook's Alluvial, finer nuggety	3	13	0

The alloy is silver with a little iron. Alluvial gold contains ·003 of iron, crushed gold ·01—supposed to be derived from the stamps.

The best gold of the field, as will be seen by the above tables, compares unfavourably with the gold of Victoria and New South Wales. The quantity, however, atones for the deficiency in quality.

It is incredible that all the reefs on the field have been discovered, or estimated at their true value. Every miner knows that the best reefs present frequent blanks, or contain for a time only "buck stone," and in the course of denudation these unpromising or irrecognizable portions of a reef may just as well occupy the surface as unmistakable auriferous mundic or brownstone. The field cannot be considered as thoroughly explored until a systematic course of tunnelling shall have been carried out in every direction, especially at right angles to the courses of reefs already known.

By Authority: JAMES C. BEAL, Government Printer, William street, Brisbane.



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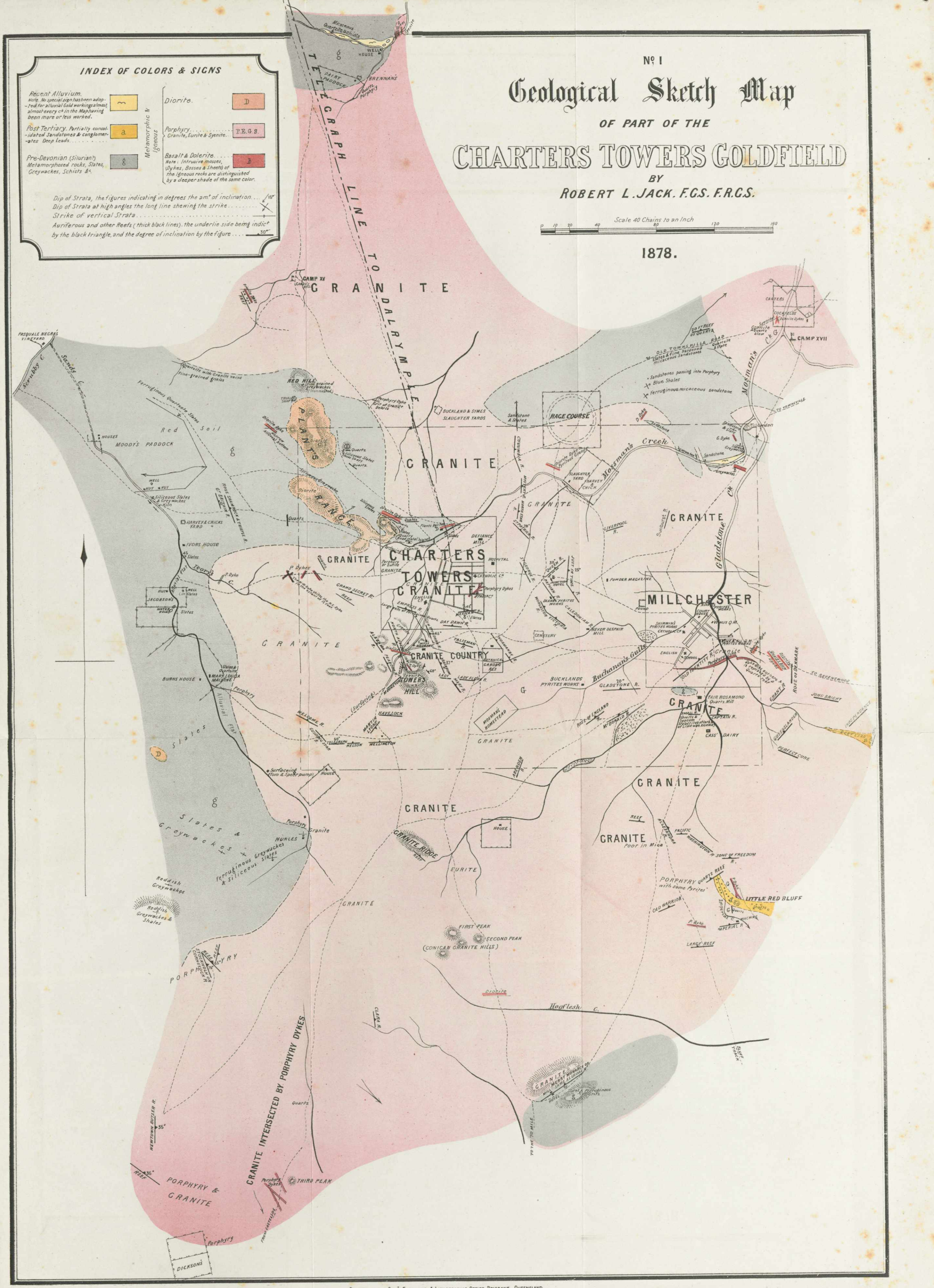

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